FAA-E-2492/2b

February 10, 1989
SUPERSEDING
FAA-E-2492/2a,6/24/75
and
Amendment 1, 5/15/78

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

TURNKEY FACILITY ESTABLISHMENT FOR INSTRUMENT LANDING SYSTEM

PART 2 SYSTEM EQUIPMENT REQUIREMENTS

Specification Change Notice (SCN)

1. Originator Name and Address	2.	3. Code Ident	4. Spec No.
Mike Rivers APS-440	[ ] Proposed [X] Approved	5. Code Ident	FAA-E-2492/2b 6. SCN No. 001

7. System Designation	8. Related ECP/NCP No.	9. Contract No.	10. Procuring Activity
ILS	NCP 11415		N/A

11. Configuration Item Nomenclature	12. Effectivity
	N/A

This notice informs recipients that the specification identified by the number (and revision letter) shown in block 4 has been changed. The pages changed by this SCN (being those furnished herewith) carry the same date as this SCN. The page numbers and dates listed below in the summary of changed pages, combined with nonlisted pages of the original issue of the revision shown in block 4, constitute the current version of this specification.

13. SCN No.	14. Pages Changed (Indicate Deletions)	S*	A*	15. Date
001	Complete revision of Specification FAA-E-2492/2a	x		2/10/89

16. Technical Concurrence	17. Date
[signature]	10/16/89

*"S" Indicates Supercedes Earlier Page; "A" Indicates Added Page

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Type IIb Type II single sideband reference glide slope conversion equipment.

Type IIc Type II wide aperture localizer antenna conversion equipment.

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Type Va Type V dual capture effect glide slope conversion equipment.

2-2. APPLICABLE DOCUMENTS

2-2.1 Government documents.- The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification and are applicable to the extent specified herein.

SPECIFICATIONS

Federal

L-P-383	Plastic Material, Polyester, Resin, Glass, Fiber Base, Low Pressure Laminated
RR-S-001301	Safety Equipment, Climbing

FAA

FAA-910	Structural Steel
FAA-C-1217	Electrical Work, Interior
FAA-C-1247	Erection of Self Supporting Towers
FAA-G-2100	Electronic Equipment, General Requirements
FAA-E-2357	Receiver, Remote Monitor, ILS
FAA-D-2494/1	Technical Instruction Book Manuscript: Electronic, Electrical and Mechanical Equipment, Requirements for Preparation of Manuscript and Production of Books

Military

MIL-E-17555	Electronic and Electrical Equipment, Accessories and Repair Parts; Packaging and Packing of

STANDARDS

Federal

Fed Std-595	Colors

FAA

FAA-STD-002	Engineering Drawings
FAA-STD-003	Paint Systems for Structures
FAA-STD-016	Quality Control System Requirements
FAA-STD-019a	Lightening Protection, Grounding, Bonding
FAA-STD-021	Configuration Management

Military

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-470	Maintainability Program Requirements
MIL-STD-471	Maintainability Demonstration
MIL-STD-472	Maintainability Prediction
MIL-STD-756	Reliability Prediction
MIL-STD-785	Reliability Program for System and Equipment Development and Production
MIL-STD-1189	Bar Code Marking
MIL-STD-1388-1A	Logistic Support Analysis
MIL-STD-1521	Technical Reviews and Audits for Systems, Equipment and Computer Software
MIL-STD-1561B	Provisioning Procedures

OTHER PUBLICATIONS

FAA Orders

OA P 8200.1	United States Standard Flight Inspection Manual
1800.8	National Airspace System Configuration Management

FAA Advisory Circulars

150/5345-2	Specification for L-810 Obstruction Lights
70/7460-1	Obstruction Marking and Lighting

Military Handbook

MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment

FCC Document	Federal Communication Commission, Rules and Regulations, Part 15, Subpart J, Radio Frequency Devices, Equipment Authorization procedure.
NTIA Manual	National Telecommunications and Information Administration Manual of Regulations and Procecures for Federal Radio Frequency Management

2-2.2 Non-Government Documents.- The following documents of the issue in effect on the date of the invitation for bids or request for proposal form a part of this specification and are applicable to the extent specified herein.

ASTM Standards

ASTM A 123	Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strip
ASTM A 153	Zinc Coating (Hot Dip) on Iron and Steel Hardware

EIA Standard

RS-222-A	Structural Standards for Steel Antenna Tower and Antenna Supporting Structures
RS-232	Interface Between Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange,

Copies of FAA documents may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the invitation for bids or request for proposals. Requests should fully identify materials desired and should cite the invitation for bids, request for proposal or the contract involved or other use to be made of the requested material.

Copies of military standards, specifications and handbooks may be requested from the U.S. Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120. (215)-679-3321.

Copies of ASTM standards may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

Copies of the EIA Standard may be obtained from the Electronic Industries Association Engineering Department, 2001 I Street, N.W., Washington, D.C. 20006.

Copies of Federal specifications and standards may be obtained from General Services Administration offices in Atlanta; Auburn, Wa.; Boston; Chicago; Denver; Fort Worth; Kansas City, Mo.; Los Angeles; New Orleans; New York; San Francisco; and Washington, D.C.

FAA Advisory Circulars		
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2-3.2.13 Mean power.- The power supplied at the RF module output during normal operation, averaged over a time sufficiently long compared with the period of the lowest frequency encountered in the modulation. A time of 1/10 second during which the mean power is greatest will be selected normally.

2-3.2.14 Carrier modulation balance.- The term "carrier modulation balance" is defined by, and will exist when, the following conditions prevail at the carrier output:

(a) Unity ratio between 90 Hz upper and lower sideband signal levels.
(b) Unity ratio between 150 Hz upper and lower sideband signal levels.
(c) Unity ratio between the total 90 Hz upper and lower sideband signals and the total 150 Hz upper and lower sideband signals.
(d) Pure amplitude modulation only, with no frequency or phase modulation components.

The above conditions result in zero DDM at the carrier output.

2-3.2.15 Sideband balance.- The term "sideband balance" is defined by, and will exist when the following conditions prevail at the sideband output.

(a) Unity ratio between 90 Hz upper and lower sideband signal levels.
(b) Unity ratio between 150 Hz upper and lower sideband signal levels.
(c) Unity ratio between the total 90 Hz upper and lower sideband signals and the total 150 Hz upper and lower sideband signals.

2-3.2.16 Total modulation balance.- The term "total modulation balance" is defined by, and will exist when, the following conditions prevail:

(a) Carrier modulation balance.
(b) Side band balance.

2-3.2.17 Sideband ratio.- The ratio of the total (90 Hz and 150 Hz) sideband power delivered at the carrier output to the total (90 Hz and 150 Hz) sideband power delivered at the sideband output.

2-3.2.18 Stray radiation.- The emission or leakage of the fundamental frequency signals from the equipment at points other than from the normal output(s).

2-3.2.19 Spurious radiation.- An emission on a frequency or frequencies which are outside the necessary band and the level of which may be reduced without affecting the corresponding transmission of information. Spurious radiations include harmonic emissions, parasitic emissions, hum, noise and intermodulation products, but exclude emissions in the immediate vicinity of the necessary band which are a result of the modulation process for the transmission of information.

2-3.2.20 Standard glide slope signal.- An RF carrier amplitude modulated simultaneously with 90 Hz and 150 Hz signals so that the sum of their separate modulation percentages equals 80 percent with the voltage waves of the 90 Hz and the 150 Hz signals simultaneously passing through zero in the same direction each 1/30 second.

2-3.2.21 Standard localizer signal.- An RF carrier amplitude modulated simultaneously with 90 Hz and 150 Hz signal so that the sum of their separate modulation percentages equals 40 percent with the voltage waves of the 90 Hz and 150 Hz signals simultaneously passing through zero in the same direction each 1/30 second.

2-3.2.22 ILS reference datum.- A point determined by the intersection of the downward extended straight line glide path with a vertical line that passes through the runway centerline at the threshold.

2-3.2.23 Two-frequency (capture effect) configuration.- A localizer or glide slope design in which the guidance signal is provided by two RF carriers lying within the same receiver channel but sufficiently spaced in frequency that their difference frequency falls outside the receiver's audio passband. One of these carriers provides a narrow-beam, high accuracy guidance signal while the other carrier provides a lower power clearance signal outside the limits of coverage of the guidance signals.

2-3.2.24 Failure.- The inability of any part, circuit, assembly, unit or group of the ILS to operate within its normal and previously established operating tolerances shall constitute a failure. It shall be specifically noted that it is not necessary that a maintenance action be required or a station outage result because of a failure.

2-3.2.25 Module.- A "module" is defined as being two or more basic parts which form a functional assembly which is a portion of a larger assembly or unit. The module is easily removed intact and replaced by plug-in, unsoldering, "quick-disconnect" fastener or equivalent means. It may or may not contain printed circuitry and it may contain active or passive devices.

2-3.2.26 Continuity of service.- That quality which relates to the rarity of radiated signal interruptions during any approach. The level of continuity of service of the localizer and or glide slope is expressed in terms of the probability of not losing the radiated guidance signals.

2-3.2.27 Integrity of signal.- That quality which relates to the trust which can be placed in the correctness of the information supplied by the facility. The level of integrity of the localizer or the glide slope is expressed in terms of the probability of not radiating false guidance signals.

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2-3.3 General system requirements.- This specification applies to the complete ILS system. All equipment furnished shall meet the requirements of this specification and the requirements of Specification FAA-G-2100. In the event of a conflict, the requirements of this specification shall take precedence over the requirements of the general specification.

2-3.3.1 Accessibility.- All assemblies, subassemblies, modules and test points that may require servicing, repair, or replacement shall be readily accessible and shall have sufficient clearance for easy access for maintenance. Major assemblies shall be completely removable from their enclosures without disassembly. Access shall be provided to modules from outside the basic equipment from the front of the equipment or through the use of swing-out chassis or pull-out drawers having slides with mechanical stops such that no strain is placed on connecting cables or disconnect plugs, or equivalent devices. Cable retractors and circuit extenders shall allow component or module operation in the open position. A board extractor and extender boards or cables, as applicable, shall be furnished in a suitable storage space within the equipment.

In lieu of a board extractor, handles may be provided on each printed wiring board. A minimum of one extender for each type of receptacle shall be furnished at each facility (Localizer, Glide Slope and Marker). Extenders are intended for the accomplishment of detailed trouble-shooting only, Normal functional checks of the equipment shall be possible through the provision of significant test points, meter outputs or other means which are readily accessible without resort to extenders, thereby allowing testing without interruption of operation.

2-3.3.2 Operating controls.- General information: Operating controls can be either mechanical (switches, potentiometers, etc.) or electronic (alphanumeric terminal, keypad, etc.). Controls essential for operation and maintenance shall be accessible either from the front panel or via an external alphanumeric terminal with an EIA RS-232C interface. The following controls, where appropriate for the specific equipment, must be provided. Controls must provide resolution and repeatability listed, regardless of the method or direction of adjustment. For electronic controls, "Control resolution" refers to the largest allowable adjustment step in either direction. Smaller steps are permitted. The absolute accuracy of the readout, or scale marking for any control shall be numerically equal to the resolution listed for the mechanical control.

PARAMETER	Control resolution Mechanical	Electronic
a) Localizer Carrier Modulation	± 0.5 %	0.5 %
b) Localizer Modulation Balance	± 0.002 DDM	0.002 DDM
c) Localizer Sideband Amplitude	± 0.2 dB	0.2 dB
d) Localizer, RF Phaser	± 3°	2°
e) Glide Slope, Carrier Modulation	± 0.5%	0.5%
f) Glide Slope Modulation Balance	± 0.002 DDM	0.002 DDM
g) Glide Slope, Sideband Amplitude	± 0.2 dB	0.2 dB
h) Glide Slope, RF Phaser	± 3°	2°
i) Sideband Reference Phaser	± 3°	2°
j) Sideband Reference Amplitude	± 0.2 dB	0.2 dB
k) Capture Effect Phasers		
Lower and Middle Antennas	± 2°	2°
Upper Antenna	± 4°	2°

2-3.3.2.1 Mechanical controls.- Mechanical controls may be provided for the functions listed above. Panel mounted controls shall be clearly labeled as to function (Sideband Amplitude, etc.). Internally mounted controls shall be clearly labeled with their maintenance data reference symbol (R3, S1, etc.).

Scale markings shall be provided sufficient that any control setting can be changed, then returned to its previous position with the specified accuracy, regardless of the direction of adjustment.

Each control shall be provided with a locking device to guard against accidental adjustment. Operating the locking device, locking or unlocking, shall not disturb the setting of the control.

2-3.3.2.2 Electronic controls.- Electronic controls may be provided for the functions listed above. The following forms of electronic control are acceptable.

(a) A panel-mounted keypad to select which parameter is to be adjusted, keys to increment or decrement the current value in steps of the specified minimum resolution, ability to directly enter a parameter value, and a display which clearly indicates what parameter is being adjusted and its current setting. It must be possible to read current settings without changing them. Keys must be clearly labeled with their functions, or a chart of functions must be provided on the front panel.

(b) A combination of increment/decrement switches, display(s), and parameter selection switches (if applicable) to accomplish adjustments in steps of the specified minimum resolution. A "fast" setting mode must be provided for making large changes in parameter settings. Depressing a switch 40 times to change, for example, from zero to twenty percent modulation, is not acceptable. If individual switches are provided for setting each parameter, they shall be clearly labeled to adjust multiple parameters, the parameter being adjusted must be clearly indicated by panel marking or display readout.

(c) An external alphanumeric terminal with a standard QWERTY keyboard. One portable terminal not exceeding 15 pounds of total weight shall be provided for each system. The terminal interface shall be EIA RS-232/C, 9600 baud minimum, using a DB-25F connector on the ILS equipment chassis. The terminal and connecting cables shall meet the requirements for Class B computing devices in accordance with Subpart J, Part 15 of the Rules and Regulations of the FCC and must be sufficiently shielded so that its operation is not influenced by RF radiation generated by ILS equipment.

The alphanumeric terminal shall display all control settings simultaneously, on a neatly formatted screen. The parameter and its current value must be clearly shown. For purposes of making adjustments, parameters must be selectable either by cursor, menu, or by typing in a name or code. For a system which requires operator input to make adjustments, on-screen help must be provided. Keys to increment or decrement a parameter setting in steps of the minimum resolution specified must be provided, as well as the ability to directly enter a parameter setting from the keyboard.

Electronically entered control settings must be stored in non-volatile memory either immediately upon entry or at the conclusion of an adjustment/maintenance session. Storing of control settings must be either automatic or transparent to the operator. It shall not be possible for equipment to be restored to normal operating status without control settings being saved. For this specification, data storage of at least 30 days is considered to be "non-volatile".

2-3.3.3 Electromagnetic interference control.- The ILS shall be designed to meet the applicable type acceptance criteria of the Federal Communications Commission (FCC) in accordance with Specifications FAA-G-2100.

All equipment furnished under this specification shall meet the applicable technical standards of Chapter 5, Aeronautical Radionavigation Stations, of the National Telecommunications and Information Administration (NTIA) Manual of Regulations and Procedures for Federal Radio Frequency Management.

2-3.3.4 Interchangeability.- Due to the high degree of functional commonality between stations, a maximum of module interchangeability shall be achieved in the design between various assemblies of the ILS with a minimum of recalibration.

2-3.3.5 Maintainability of electronic equipment

2-3.3.5.1 Corrective maintenance requirements.- The localizer, glide slope and marker beacon station electronic equipment shall possess a mean, critical percentile, critical maintenance time (h_o) of 30 minutes or less and a maximum tolerable mean corrective maintenance time (H_1) of 45 minutes. The producer's risk (a) shall be .05 and consumer's risk (b) shall be .05.

2-3.3.5.2 Preventive maintenance requirements.- The mean preventive maintenance time (MPMT) of the maximum electronic equipment configuration for either type of station shall not exceed one hour in 336 hours of operation, including inspection and checks to assure performance. Ninety-five percent of all routine procedures shall be accomplished in less than 15 minutes. No single group of periodic procedures shall require more than two hours time or be required more frequently than every 2000 hours. Any parts or components requiring preventive maintenance, as well as system checks not revealed by the monitor, shall be specified by the supplier with recommended maintenance and replacement intervals.

2-3.3.6 Reliability of electronic equipment

2-3.3.6.1 Localizer MTBF.- The localizer station shall have a specified MTBF of not less than 2000 hours when installed on-site as a serial reliability model.

2-3.3.6.2 Glide Slope MTBF.- The glide slope station shall have a specified MTBF of not less than 2000 hours when installed on-site as a serial reliability model.

2-3.3.6.3 Marker beacon MTBF.- The marker beacon station shall have a specified MTBF of not less than 10,000 hours when installed on-site.

2-3.3.6.4 Continuity of service.- The continuity of service of the type V localizer station shall be equal to or greater than $1 - 2x10^{-6}$ in any period of 30 seconds. The continuity of service of the type V glide slope station shall be equal to or greater than $1 - 2x10^{-6}$ in any period of 15 seconds.

2-3.3.6.5 Integrity of signal.- The integrity of the signal from a type V localizer or glide slope station shall be equal to or greater than $1 - 0.5 \times 10^{-9}$ in any one aircraft landing operation.

2-3.3.7 Service conditions

2-3.3.7.1 Environmental.- For localizer and glide slope equipment housed inside shelters, ambient conditions shall be those of Environment II of FAA-G-2100. For marker beacon stations and any equipment not housed in shelters, the ambient conditions shall be those of Environment III of FAA-G-2100.

2-3.3.8. Primary power.- The localizer, glide slope and marker beacon equipment shall be designed to operate on a nominal 120/240 volt, 60 Hz, three wire, single-phase AC power source.

2-3.3.8.1 Standby power.- The localizer and glide slope stations shall contain a continuously engaged or floating battery power supply system which will provide for continued normal operation if the primary power fails. To maintain the batteries in operational readiness, a trickle charge shall be supplied to recharge the batteries during the period of available primary power. Upon loss and subsequent restoration of power, the batteries shall be restored to full charge, from a (50) fifty percent discharged condition, within 36 hours. When primary power is applied, the state of the battery charge shall in no way cause harm to or affect the operation of the respective localizer or glide slope station. The battery supply shall permit continuation of normal operation for not less than (4) four hours under the normal test conditions of FAA-G-2100. Additionally the equipment shall meet all specification requirements with the exception of standby power operation without batteries installed.

2-3.3.9 Test points and test facilities.- The ILS design shall incorporate indicators, warning signals, test jacks and test points as necessary to facilitate trouble shooting and malfunction isolation to the optimum functional level. Test points shall be provided to check essential waveforms and voltages and for the injection of test signals. The test points shall be strategically located for easy accessibility. They should be grouped together in a minimum number of different locations and each shall be labeled and designed for easy attachment of test probes and test equipment. Microprocessor based equipment shall perform a basic microprocessor and memory functional test automatically upon application of power.

2-3.3.10 RF power metering.- Each VHF localizer station, UHF glide slope station, and marker beacon station shall be provided with built-in line sections, with metering jacks, which will accept standard Bird Electronic Corporation wattmeter elements (not to be supplied under this specification section), for the measurement of RF power levels. The metering jack of each line section shall be connected through a selector switch to a waveform jack and meter. The meter shall be panel mounted in each facility. The accuracy of the power level indications shall be within ± 8 percent of full scale meter readings. In lieu of the specified built-in line sections, the contractor may provide built-in power sensors with a minimum accuracy of ± 8 percent. If sensors are used for this purpose, an RF test signal within the range of 150 to 800 millivolts shall be provided for external measurement of modulation. The output impedance of the RF test signal source shall be 50 ohms nominal, and shall be provided through a female BNC connector.

2-3.3.11 Test meter.- A meter, meters, or other type of indicator shall be provided to allow convenient monitoring of functional parameters required for initial equipment tune-up, preventive and corrective maintenance.

2-3.3.12 Local status indicators.- Both the localizer and glide slope stations shall be provided, as a minimum, with visual indicator lamps to indicate operational status as follows:

(a) Station normal (green)
(b) Monitor alarm (red)
(c) Monitor alarm by-pass (amber)

2-3.3.13 Tools and test equipment.- The variety and number of special tools and test equipment required to achieve and maintain the performance characteristics specified for the ILS equipment shall be held to a minimum. Special tools shall comply with the requirements of MIL-STD-454, Requirement 63. When peculiar tools or test cables are required for initial adjustment, testing, or maintenance, they shall be provided by the contractor. In addition, a convenient means of mounting the tool or cable shall be provided at the unit assembly. It shall be possible to perform all adjustments and tests necessary to initially tune, test and maintain the localizer, glide slope, markers and monitoring system with the built-in circuits incorporated in the equipment and the Government authorized test equipment. Government test equipment will consist of those items listed in the invitation for bids or request for proposals.

2-3.3.14 Solid-state design.- All active electronic devices shall be semiconductor devices or microelectronic devices in accordance with FAA-G-2100.

In lieu of conformance with MIL-M-38510, microelectronic components must be vendor tested in accordance with MIL-STD-883. Plastic packaged microelectronic components shall not be used.

2-3.3.15 Modular construction.- The ILS design shall make maximum use of sealed components and easily removable plug-in module assemblies containing one or more related circuits. The design of the modules shall permit disassembly of the module for maintenance or repair.

2-3.3.16 Printed wiring boards.- All printed wiring boards shall be in accordance with FAA-G-2100 with the following exceptions:

1) All electrical connection holes in printed wiring boards and cards shall be the plated through hole or eyelet type.

2) The boards shall be plug-in type with suitable guides and shall be keyed such that they can be inserted only in the correct receptacle and in the correct orientation. Gold-plated edgeboard type connectors may be used in lieu of pin-and-socket connectors.

3) Surface mount technology components may be used.

2-3.3.17 Finish and color.- The glide slope antenna tower, the near field detector support, and localizer antenna supports shall be painted in an obstruction marking configuration in accordance with FAA Advisory Circular 70/7460-1. The colors shall be aviation orange, color 12197 and insignia white, color 17875 in accordance with Federal Standard 595. Painting of all exterior surfaces shall be in accordance with FAA-STD-003.

2-3.3.18 Voltage regulators.- External voltage regulating transformers shall not be used with this equipment. Voltage regulation in the equipment shall be provided (if required) by means of voltage or current regulators, or both, in the DC output circuit of the power supplies.

2-3.3.19 Antenna support material and design.- The VHF marker beacon antenna support shall be a self-supporting steel tower. Glide slope antenna supports shall be self-supporting steel towers. Localizer antenna element supports shall be of self-supporting steel or aluminum and the complete antenna array shall be designed for installation on a ground mounted support or on an elevated platform support. The antenna array support structure (elevated or ground mounted) is not to be furnished under this specification. Heights of towers and platforms shall be as indicated in the antenna requirements set forth herein. The design wind loads, manufacture and workmanship, factory finish, plans and markings, foundation design and protective grounding for steel towers and supports shall be in accordance with EIA Standard RS-222-A and FAA specifications FAA-910 and the localizer, glide slope, markers and monitoring system with the built-in circuits incorporated in the equipment and the Government authorized test equipment. Government test equipment will consist of those items listed in the invitation for bids or request for proposals.

2-3.3.14 Solid-state design.- All active electronic devices shall be semiconductor devices or microelectronic devices in accordance with FAA-G-2100.

In lieu of conformance with MIL-M-38510, microelectronic components must be vendor tested in accordance with MIL-STD-883. Plastic packaged microelectronic components shall not be used.

2-3.3.15 Modular construction.- The ILS design shall make maximum use of sealed components and easily removable plug-in module assemblies containing one or more related circuits. The design of the modules shall permit disassembly of the module for maintenance or repair.

2-3.3.16 Printed wiring boards.- All printed wiring boards shall be in accordance with FAA-G-2100 with the following exceptions:

1) All electrical connection holes in printed wiring boards and cards shall be the plated through hole or eyelet type.

2) The boards shall be plug-in type with suitable guides and shall be keyed such that they can be inserted only in the correct receptacle and in the correct orientation. Gold-plated edgeboard type connectors may be used in lieu of pin-and-socket connectors.

3) Surface mount technology components may be used.

2-3.3.17 Finish and color.- The glide slope antenna tower, the near field detector support, and localizer antenna supports shall be painted in an obstruction marking configuration in accordance with FAA Advisory Circular 70/7460-1. The colors shall be aviation orange, color 12197 and insignia white, color 17875 in accordance with Federal Standard 595. Painting of all exterior surfaces shall be in accordance with FAA-STD-003.

2-3.3.18 Voltage regulators.- External voltage regulating transformers shall not be used with this equipment. Voltage regulation in the equipment shall be provided (if required) by means of voltage or current regulators, or both, in the DC output circuit of the power supplies.

2-3.3.19 Antenna support material and design.- The VHF marker beacon antenna support shall be a self-supporting steel tower. Glide slope antenna supports shall be self-supporting steel towers. Localizer antenna element supports shall be of self-supporting steel or aluminum and the complete antenna array shall be designed for installation on a ground mounted support or on an elevated platform support. The antenna array support structure (elevated or ground mounted) is not to be furnished under this specification. Heights of towers and platforms shall be as indicated in the antenna requirements set forth herein. The design wind loads, manufacture and workmanship, factory finish, plans and markings, foundation design and protective grounding for steel towers and supports shall be in accordance with EIA Standard RS-222-A and FAA specifications FAA-910 and the pulse shapes specified in Table I when applied to a 25-ohm resistive load. Pulse shapes need not be maintained when testing equipment (i.e., distortion due to load impedances of other than 25 ohms is tolerable); however, pulse energy input to the equipment under test shall remain as specified in Table I.

2-3.3.21.1 Power line transients.- Using pulses a and b of Table I (2-3.3.21) the following transients shall be applied to each equipment power line:

a. A single pulse applied a minimum of six times in succession at a rate not to exceed 1 Hz.

b. A single burst of pulses (consisting of a minimum of 40 pulses at a PRF of 10 Hz) applied a minimum of six times at intervals of approximately three minutes (pulse b only).

2-3.3.21.2 Communication, control. and monitor line transients.- Using pulses b, c, and d of Table I (2-3.3.21) the following transients shall be applied to each communication, control, and monitor line:

a. A single pulse applied a minimum of six times in succession. (Pulses b and c).

b. A single burst of pulses (consisting of a minimum of 40 pulses at a PRF of 10 Hz) applied a minimum of six times at intervals of approximately three minutes. (Pulse b only).

c. A single burst of pulses (consisting of a minimum of 40 pulses at a PRF of 100 Hz) applied a minimum of six times at intervals of approximately three minutes. (Pulse d only).

2-3.3.21.3 Spare capacity.- The design of the transient protective equipment shall be such as to provide the capability for the future addition by the Government of protective devices for up to a total of two (2) pairs of communication lines or monitor lines or control lines or a combination thereof at any protected station.

2-3.4 Detailed equipment requirements.

2-3.4.1 System configuration.- The system configurations shall be of one or more of the types listed in 2-1.2 as specified in the contract schedule.

2-3.4.2 System performance.- The Instrument Landing System shall demonstrate compliance with Category I, Category II or Category III, performance as defined in paragraphs 2-3.2.1, 2-3.2.2 or 2-3.2.3. FAA commissioning will be accomplished by the methods described in FAA Handbook OA P 8200.1. The requirements of FAA Handbook OA P 8200.1 must be met in addition to the requirements of this specification.

2-3.4.3 VHF localizer station.- A completely equipped VHF localizer station shall consist of the following:

(a) Transmitter/s with associated modulation and control equipment.
(b) Localizer antenna array with associated cabling, stripline, divider network or distribution unit, integral monitor pickup devices and stripline combining unit, obstruction lights, antenna element support structures, etc.
(c) One localizer monitor group.
(d) A type I station or a type V station (2-1.2) shall include automatic changeover equipment (2-3.4.3.1.9).
(e) A type V station (2-1.2) shall include a far field monitor group.

2-3.4.3.1 VHF localizer station performance.- The VHF localizer station shall provide guidance in the horizontal plane to aircraft in approaches to, and landings at airfields. The radiation from the localizer antenna group shall produce a composite field pattern that is amplitude modulated by a 90 Hz and a 150 Hz tone and 1020 Hz identification tone. The radiation field pattern shall produce a course sector with one tone predominating on one side of the course and the other tone predominating on the opposite side. When an observer faces the localizer from the approach end of the runway, the depth of modulation of the radio frequency carrier due to the 150 Hz tone shall predominate on his right hand side and the depth of modulation of the radio frequency carrier due to the 90 Hz tone shall predominate on the left hand side. All horizontal angles employed in specifying the localizer field patterns shall originate from the center of the localizer antenna group which provides the signals used in the front course sector.

2-3.4.3.1.1 Radio frequency.- The localizer frequency shall be capable of operation in 0.05 MHz increments across the band of 108 to 112 MHz. The frequency tolerance shall not exceed ± 0.002 percent over the service conditions.

2-3.4.3.1.2 Coverage.- With the transmitter power output reduced to the monitor RF level alarm point, the localizer coverage sector shall meet the requirements of FAA Order OA P 8200.1. Coverage beyond ± 35 degrees is not required. A type V (2-1.2) two frequency system shall provide a ratio of course signal to clearance signal strength in space within the front course sector to the coverage limit of not less than 10 dB.

2-3.4.3.1.3 Polarization.- The emission from the localizer shall be horizontally polarized. The vertically polarized component of the radiation on the course line of the single frequency arrays shall not exceed that which corresponds to a DDM error of 0.008, when an aircraft is positioned on the course line, is in a roll attitude of 20 degrees from the horizontal, and is measuring the DDM with a standard calibrated localizer receiver. Under the same conditions of verification, the vertically polarized component of the two-frequency system shall not exceed 0.005 DDM.

2-3.4.3.1.4 Modulation.- The nominal depth of modulation of the radio frequency carrier due to each of the 90 Hz and 150 Hz tone shall be 20 percent and shall be maintained within the limits of 18 and 22 percent.

2-3.4.3.1.5 Course alignment accuracy.- Based on a nominal sector width of 700 feet, at threshold, the equipment shall be capable of maintaining (except for radiated signal interference) a course line within ± 0.1 degrees from the runway centerline at the ILS reference datum and adjusting the same between ± 0.2 degrees from the runway centerline at the ILS reference datum.

2-3.4.3.1.6 Displacement sensitivity.- The nominal displacement sensitivity within the half course sector at the ILS reference datum shall be 0.00044 DDM/foot, based on a nominal sector width of 700 feet at the ILS reference datum. The increase of DDM shall be substantially linear with respect to angular displacement from the front course line up to an angle on either side of the front course line where the DDM is 0.180. From that angle to ± 35 degrees, the DDM shall not be less than 0.155. When the course is widened sufficiently to cause an alarm, the DDM shall not be less than 0.165 from ± 4 to ± 10 degrees, and 0.139 from ± 10 degrees to the limits of coverage.

2-3.4.3.1.7 Course sector width.- The localizer sector width shall be tailored to a value of 700 feet at the runway threshold, except that for Category I operation it shall be not less than 3.0° and for any Category of operation it shall not be more than 6.0° and shall be maintained within 10 percent of that value. The sector width shall be easily adjustable between the values of 2.4 and 7.2 degrees. The course sector width of the clearance array of the two-frequency (capture effect) system shall be a nominal 10 degrees and shall be easily adjustable (2-3.4.3.2.14) to provide a width of from 7 to 13 degrees.

2-3.4.3.1.8 Identification.- The localizer shall provide for the simultaneous transmission of an identification signal on the same radio frequency carrier as used for the localizer function. The transmission of the identification signal shall not interfere in any way with the basic localizer function. The identification signal shall be produced by Class A2 modulation of the radio frequency carrier or carriers using a modulation tone of 1020 ± 15 Hz. In a type V (2-1.2) system where both carriers are modulated with the identification signal, the relative phase of the modulations shall be such as to preclude the occurrence of nulls within the coverage area of the localizer. The identification signal shall employ the International Morse Code and shall normally consist of three letters. It shall be preceded by the International Morse Code signal of the letter "I". The Identification signal shall be transmitted at a speed corresponding to approximately 7 words per minute, and shall be repeated at approximately equal intervals, not less than 6 times per minute, at all times during which the localizer is available for operational use. During all times that the localizer is not available for operational use, as for example during removal of navigational components or during test or maintenance, the identification signal shall be suppressed.

2-3.4.3.1.8.1 Identification modulation range.- The identification modulation of the carrier shall be adjustable to all percentages from zero to 15 percent. A continuously adjustable mechanical control or electronic control adjustable in steps of 1 percent shall be provided for this purpose.

2-3.4.3.1.9 Automatic changeover unit (dual facility).- The automatic changeover unit shall cause the transmitter/s to cease radiation (when a station fault, 2-3.4.3.4.3, is detected) and cause the standby transmitter/s to radiate. The changeover unit shall configure the antenna system to the radiating transmitter/s.

2-3.4.3.2 Transmitter.- The transmitter, or transmitters in a two frequency (capture effect) system, shall consist of an RF module, a modulator module, and an identification keyer module.

2-3.4.3.2.1 Transmitter output power.- The transmitter carrier output power shall be adjustable over the range of at least 40 percent to 100 percent of the rated transmitter output power. Adjustment over this range shall not change the modulation balance by more than 0.002 DDM, the course width by more than 2.0 percent, the percentage of identification modulation by more than 10 percent of normal, and carrier modulation by more than ± 1.0 percent.

2-3.4.3.2.2 Transmitter stability.- After initial adjustment under normal test conditions for optimum transmitter performance, changes over the service conditions shall not exceed the limits tabulated below:

(a)	Carrier power at carrier output	± 10 percent
(b)	Sideband ratio	± 0.5 dB
(c)	Carrier modulation	± 1 percent (each tone)
(d)	Carrier modulation balance	± 0.005 DDM
(e)	Sideband balance	± 0.3 dB
(f)	RF phase between carrier and sideband outputs	± 10 degrees
(g)	Navigational tone frequency	± 1.5 percent
(h)	Transmitter frequency	± .002 percent of the assigned frequency (see paragraph 2-3.4.3.2.5).

2-3.4.3.2.3 Stabilization time.- After initial adjustment under normal test conditions, changes from the initial room temperature readings occurring between 0.5 seconds and 15 minutes after initial application of power under each of steps 3, 6 and 8 of the type test procedure of Specification FAA-G-2100 (modifies FAA-G-2100 for this application) shall not exceed the limits tabulated below. The reading for each parameter shall be taken at: 0.5 seconds after energizing, and on a continuous recording basis for 15 minutes after energizing.

(a)	Carrier power at carrier output	± 10 percent
(b)	Sideband ratio	± 0.5 dB
(c)	Carrier modulation	± 1.0 percent (each tone)
(d)	Carrier modulation balance	± 0.005 DDM
(e)	Sideband balance	± 0.3 dB
(f)	RF Phase between carrier and sideband output	± 10 degrees
(g)	Navigation tone frequency	± 1 percent
(h)	Identification frequency	± 15 Hz
(i)	Transmitter frequency	± .002 percent of the assigned frequency (see paragraph 2-3.4.3.2.5).

<u>2-3.4.3.2.4 Control functions</u>.- A switch or control shall be provided to turn the transmitter output radiation on and off. In addition, it shall be possible to select either local or remote control of this function.

<u>2-3.4.3.2.5 Crystal</u>.- Two of each required crystal shall be furnished with each transmitter in accordance with a listing of channel frequency assignments which will be furnished by the government. In order to change the transmitter frequency, the crystal shall be the only component requiring replacement. The crystal shall be easily removable from a plug-in socket. In lieu of a set of crystals, transmitter frequency may be controlled by a crystal-referenced synthesizer adjustable over the full frequency range of 108 to 112 MHz in steps of .05 MHz.

<u>2-3.4.3.2.6 Crystal oven</u>.- A crystal oven shall not be used.

<u>2-3.4.3.2.7 Resonance points</u>.- There shall be no indication of more than one resonance point over the complete range of travel adjustment for all controls normally used in tuning or adjusting the transmitter to meet equipment specification requirements. This requirement shall be met over the specified frequency range either during the procedure of tuning the transmitter or after all stages are tuned to resonance, regardless of the transmitter power output.

<u>2-3.4.3.2.8 Indicator lights</u>.- Indicator lights shall be provided and mounted on the front panel of the RF unit to indicate the application of AC power and local-remote control.

<u>2-3.4.3.2.9 Modulator assembly design</u>.- The modulator assembly shall provide (1) an output containing the RF carrier modulated by the navigation tones and identification tone, (2) an output containing only the separate sideband frequencies of the navigation tones. The modulator shall be of electronic, solid state design.

<u>2-3.4.3.2.10 Modulation tones</u>.- The modulating tones shall be 90 Hz and 150 Hz within ± 1.5 percent.

<u>2-3.4.3.2.11 Audio phase of modulation tones</u>.- The modulating tones shall be phase-locked such that the demodulated 90 and 150 Hz signals appearing at the carrier output pass through zero within 50 microseconds of each other in the same direction, every 1/30 second. In a two frequency

(a)	Carrier power at carrier output	± 10 percent
(b)	Sideband ratio	± 0.5 dB
(c)	Carrier modulation	± 1.0 percent (each tone)
(d)	Carrier modulation balance	± 0.005 DDM
(e)	Sideband balance	± 0.3 dB
(f)	RF Phase between carrier and sideband output	± 10 degrees
(g)	Navigation tone frequency	± 1 percent
(h)	Identification frequency	± 15 Hz
(i)	Transmitter frequency	± .002 percent of the assigned frequency (see paragraph 2-3.4.3.2.5).

2-3.4.3.2.4 Control functions.- A switch or control shall be provided to turn the transmitter output radiation on and off. In addition, it shall be possible to select either local or remote control of this function.

2-3.4.3.2.5 Crystal.- Two of each required crystal shall be furnished with each transmitter in accordance with a listing of channel frequency assignments which will be furnished by the government. In order to change the transmitter frequency, the crystal shall be the only component requiring replacement. The crystal shall be easily removable from a plug-in socket. In lieu of a set of crystals, transmitter frequency may be controlled by a crystal-referenced synthesizer adjustable over the full frequency range of 108 to 112 MHz in steps of .05 MHz.

2-3.4.3.2.6 Crystal oven.- A crystal oven shall not be used.

2-3.4.3.2.7 Resonance points.- There shall be no indication of more than one resonance point over the complete range of travel adjustment for all controls normally used in tuning or adjusting the transmitter to meet equipment specification requirements. This requirement shall be met over the specified frequency range either during the procedure of tuning the transmitter or after all stages are tuned to resonance, regardless of the transmitter power output.

2-3.4.3.2.8 Indicator lights.- Indicator lights shall be provided and mounted on the front panel of the RF unit to indicate the application of AC power and local-remote control.

2-3.4.3.2.9 Modulator assembly design.- The modulator assembly shall provide (1) an output containing the RF carrier modulated by the navigation tones and identification tone, (2) an output containing only the separate sideband frequencies of the navigation tones. The modulator shall be of electronic, solid state design.

2-3.4.3.2.10 Modulation tones.- The modulating tones shall be 90 Hz and 150 Hz within ± 1.5 percent.

2-3.4.3.2.11 Audio phase of modulation tones.- The modulating tones shall be phase-locked such that the demodulated 90 and 150 Hz signals appearing at the carrier output pass through zero within 50 microseconds of each other in the same direction, every 1/30 second. In a two frequency

2-3.4.3.2.19 Distortion of demodulated navigation tones. With the equipment adjusted for optimum conditions, the signals appearing at the carrier output test jack and the sideband output test jack, when it is properly demodulated, shall be such as to produce a demodulated signal with equal 90 and 150 Hz components and distortion components which do not exceed the following:

Frequency	Distortion component referred to 90 or 150 Hz signal
180 Hz	3 percent
270 Hz	4 percent
300 Hz	4 percent
450 Hz	4 percent
All other frequencies within the range of 30 to 4000 Hz	2 percent

In addition, the total harmonic distortion shall not exceed 10 percent. The above distortion requirements shall also be met when the input power to the modulator is varied over the specified range of the transmitter power output.

2-3.4.3.2.20 Identification keyer.- The transmitter shall include solid-state electronic keying facilities that shall modulate the carrier with a 1020 Hz tone without interruption of the carrier. The use of electro-mechanical devices shall not be employed. The keyer shall provide character timing as follows:

(a)	Dot length:	0.125 second
(b)	Dash length:	0.375 second
(c)	Length of space between dots and dashes in a continuous series and within a code character	0.125 second
(d)	Length of space between characters	0.375 second

The keying rates shall remain within ± 15 percent of the design center values under the service conditions of temperature and humidity. Keying pulses shall start without undesirable transients, shall have no discontinuities, and shall stop without undesirable transients. Transient peaks due to keying shall not exceed 2 percent of the peak amplitude of the normal audio frequency waveform at the modulator output. A multi-position switch, or control shall be provided to enable selection of either keyed or unkeyed modulation or to remove all identification modulation from the carrier.

2-3.4.3.2.20.1 DME keying output.- Provisions shall be provided for synchronous keying of an associated DME facility (not furnished under this specification). When DME identification is desired, every fourth cycle of localizer transmission identification keying shall be omitted and presented instead in the form of continuity keying of the DME output terminals. Thus the DME will be keyed with one cycle of Morse Code identification approximately every 30 seconds, followed by three (3) localizer keying cycles. Keying of the DME is accomplished by providing a short circuit at two terminals with a maximum resistance of 250 ohms. Current through the terminals shall not exceed 20 ma and the open circuit voltage shall not exceed 50 V DC. DME keying shall not be affected by operation of the localizer keyer switch or control (2-3.4.3.2.20).

2-3.4.3.3 Localizer antenna array.- The equipment specified herein, consists of three types of directional localizer antenna arrays. The arrays shall be broad banded and operate throughout the range of 108 to 112 MHz without adjustments. Two of the versions shall operate as single frequency systems, while the third version shall operate as a two-frequency system. Each array shall have its own integral monitor system. Modular construction shall be utilized throughout the arrays such that the smaller single frequency version may be converted to the larger single frequency array by merely adding additional elements with like spacing and replacing or converting the distribution and monitor networks. The Government will specify the quantities of each array to be supplied. The antenna systems shall be prefabricated and include radiating elements, radomes (if required), mounting bases and support posts, distribution network/s, in-line phasing detector/s, integral monitoring, monitor combining network/s and detection system/s, interconnecting RF cables, obstruction lights and AC power cables. The in-line phasing detector/s shall consist of an RF sampler and detection system, provided for permanent installation at the appropriate output of the distribution units to enable the establishment and maintenance of the optimum carrier sideband to sideband only phase relationship in the array. The 90/150 hertz composite audio level signal from the in-line phasing detectors shall be available for routing to the localizer shelter for termination in a standard telephone jack.

2-3.4.3.3.1 Array options and antenna patterns.- The three types of antenna arrays to be furnished under this specification are described below:

2-3.4.3.3.1.1 Option 1.- This shall be the smaller of the two single frequency arrays and is intended for use at the least difficult sites. It shall consist of identical elements with appropriate spacing and excitation to produce the carrier and sideband patterns described in (a), (b), and (c) below.

(a) Carrier radiation. The carrier radiation shall have a beam width not exceeding ± 11 degrees at the half-power points. From the half-power points, the carrier field intensity shall decrease essentially linearly to at least 11 dB below the zero degree value at ± 20 degrees. From this point, the carrier field intensity shall decrease essentially linearly to at least 16 dB below the zero degree value at ± 35 degrees and continue to decrease to at least 23 dB at ± 50 degrees. From ± 50 degrees to ± 180 degrees, the radiation shall remain at least 23 dB below the zero degree value. The peak value of the carrier radiation shall occur within ± 0.1 degrees of a line perpendicular to the center of the array and this line is designated as zero degrees relative azimuth.

(b) Sideband radiation. The sideband radiation shall peak at an angle not greater than ± 8 degrees and at ± 20 degrees shall be at least 13 dB below the peak values. From this point the sideband radiation shall decrease essentially linearly to at least 23 dB at ± 60 degrees. From ± 60 degrees to ± 180 the radiation shall remain at least 23 dB below the peak values. The front course nulls shall occur within ± 0.1 degrees of zero degrees and the field intensity at this point shall be at least 30 dB below the peak values.

(c) Radiation symmetry. The carrier and sideband radiation shall be symmetrical about the zero degree line within 0.5 dB between ± 8 degrees.

2-3.4.3.3.1.2 Option 2.- This shall be the larger of the two single frequency arrays and is intended for use at moderately difficult sites. The configuration of this array shall be such that it may be formed from the Option 1 array by adding additional elements with like spacing on each side of the Option 1 array and replacing or converting the RF distribution and monitor combining networks. The carrier and sideband radiation pattern shall conform with (a), (b) and (c) below.

(a) Carrier radiation. The carrier radiation shall have a beam width not exceeding ± 4.5 degrees at the half-power points and at ± 10 degrees shall be at least 12 dB below the zero degree value. From this point the carrier field intensity shall decrease essentially linearly to at least 23 dB at ± 45 degrees and from ± 45 degrees to ± 180 degrees shall be at least 23 dB below the zero degree value. The peak value of the carrier radiation shall occur within ± 0.05 degrees of a line perpendicular to the center of the array and this line is designated as zero degrees relative azimuth.

(b) Sideband radiation. The sideband radiation shall peak at an angle not greater than ± 5 degrees and at ± 11 degrees shall be at least 8 dB below the peak value. From this point the sideband radiation shall decrease essentially linearly to at least 23 dB at ± 40 degrees. From ± 40 degrees to ± 180 degrees the radiation shall be at least 23 dB below the peak values. The front course null shall occur within ± 0.05 degrees of zero degrees and the field intensity at this point shall be at least 30 dB below the peak values.

(c) Radiation symmetry. The carrier and sideband radiation shall be symmetrical about the zero degree line within 0.5 dB between ± 5 degrees.

2-3.4.3.3.1.3 Option 3.- This shall be the two frequency (capture-effect) array and is intended for use with a type V system at Category II or Category III sites. It shall consist of identical elements with appropriate spacing and excitation so as to produce the pattern described in 2-3.4.3.3.1.3.1.

2-3.4.3.3.1.3.1 Two frequency localizer antenna performance.- The antenna array shall be designed to provide a maximum of ± 3 1/2 degrees beam width (except for clearance signal) as measured at the half power points with power reduction of 20 dB or more below course line power for angles exceeding 10 degrees. From ± 40 degrees to ± 170 degrees, the course radiation shall be at least 26 dB below course line power. The peak value of the carrier radiation shall occur within ± 0.1 degrees of a line perpendicular to the center of the array and this line is described as zero degrees relative azimuth. The peak level of the course producing sideband radiation from the antenna shall occur at angles no greater than ± 5.0 degrees from zero degrees relative azimuth. Sideband radiation at angles greater than ± 11 degrees shall be at least 20 dB below the peak value and at angles greater than ± 15 degrees shall be at least 26 dB below the peak value. The front course null shall be at least 30 dB below the peak value. For the separately generated clearance signals, a minimum of 10 dB differential must be obtainable on the glide path between the course and clearance RF signal strengths on the localizer centerline.

2-3.4.3.3.2 Frequency range.- In all options, the complete localizer antenna system consisting of the distribution network/s, antenna array, and monitor combining network/s shall be designed for operation throughout the band of 108 to 112 MHz. All specification requirements shall be met throughout this range without tuning, electrical, or mechanical adjustments.

2-3.4.3.3.3 Obstruction lights.- Two each double obstruction lights per FAA Advisory Circular AC 150/5345-2 shall be provided for mounting on both ends of the antenna array. The lamps in each fixture shall be wired in parallel and each lamp shall be rated at 100 watts.

2-3.4.3.3.4 RF distribution unit.- All option/s of the array shall be furnished with the appropriate stripline RF distribution unit/s to provide the proper current excitation to generate the specified array patterns. The design characteristic impedance of the "carrier" input port/s and the "sideband-only" input port/s shall be 50 ohms. The input voltage standing wave ratio (VSWR) at each of the inputs shall not exceed 1.20 over the frequency band and service conditions of temperature and humidity. A weather proof box with hinged covers and hasp shall be provided to house all the RF distribution circuits. A terminal block shall be provided inside the box for connecting AC power to the obstruction lights. In addition, two each weather proof, three wire exterior convenience receptacles shall be mounted on the rear surface of the box.

2-3.4.3.3.5 Course width.- The antenna array systems shall be capable of providing the course widths specified in paragraph 2-3.4.3.1.7. This shall be accomplished only by changing the relative power level of the sideband only signal with respect to the carrier signal; no additional equipment or substitution of equipment is permitted. Additionally, all array systems shall meet all performance requirements specified in paragraphs 2-3.4.3.1.2 and 2-3.4.3.1.3 and paragraphs 2-3.4.3.1.5 through 2-3.4.3.1.7.

2-3.4.3.3.6 Horizontal RF patterns.- The horizontal RF patterns of the three array options shall be as specified in 2-3.4.3.3.1.1 and 2-3.4.3.3.1.2 and 2-3.4.3.3.1.3. The various shapes of the antenna patterns shall be determined by the relative distribution of signal across the array and the directional property of the radiating element. If screens, reflecting bars, or other passive reflectors outside the plane of the radiating element are employed in obtaining the specified patterns, the monitor system must detect any out of tolerance changes in the radiation characteristics resulting from physical damage or other deformation of the items used.

2-3.4.3.3.7 Vertical RF pattern.- Vertical directivity shall be designed into each antenna element such that the peak of the major lobe shall occur at an elevation angle not greater than 15 degrees and the beam width of the major lobe shall be not greater than 16 degrees at the half-power points when the antenna is mounted one wavelength above ground. Minor lobes shall be at least 8 dB below the peak of the major lobe when mounted as specified above.

2-3.4.3.3.8 Array height.- The overall height of the array including reflectors if used when mounted on the normal array support, shall not exceed 10 feet.

2-3.4.3.3.9 Intercoupling.- The isolation between those adjacent antenna elements in the array with the closest spacing as measured between the input connector of the driven element and the monitor output of the undriven element shall be at least 26 dB.

2-3.4.3.3.10 Integral monitoring.- Integral monitoring signals shall be provided for all arrays which are directly proportional to the radiated signal. The monitoring signals from the elements in each single frequency array shall be combined in such a manner that two separate RF signals are provided which describe the radiated signal "on-course" and the radiated signal at angles 1.5 to 3.0 degrees "off-course". The monitoring signals from the elements in the two-frequency array shall be combined in such a manner that 2 separate RF signals are provided which describe the radiated signals "on-course" and the radiated signal at angles 1.5 to 3.0 degrees "off-course" for the course array and 2 separate RF signals are provided which describe the radiated signal at angles of 8.0 to 10.0 degrees "off-course" for the clearance array. These monitoring signals so provided shall correlate with the signals that would be obtained with monitoring dipoles at the specified locations in the unobstructed far field. No tuning shall be required in the detector or monitor combining network for changes in frequency or input power. In addition to these specifications, the developed monitor signals shall be of a nature to comply in full with the intent and the specifications for monitoring localizer arrays as specified in paragraphs 2-3.4.3.4 thru 2-3.4.3.4.2. A weather proof box with removable cover shall be provided to house the monitor combining unit or at the contractor's option, the combining unit may be housed in the RF distribution unit (2-3.4.3.3.4).

substitution of equipment is permitted. Additionally, all array systems shall meet all performance requirements specified in paragraphs 2-3.4.3.1.2 and 2-3.4.3.1.3 and paragraphs 2-3.4.3.1.5 through 2-3.4.3.1.7.

2-3.4.3.3.6 Horizontal RF patterns.- The horizontal RF patterns of the three array options shall be as specified in 2-3.4.3.3.1.1 and 2-3.4.3.3.1.2 and 2-3.4.3.3.1.3. The various shapes of the antenna patterns shall be determined by the relative distribution of signal across the array and the directional property of the radiating element. If screens, reflecting bars, or other passive reflectors outside the plane of the radiating element are employed in obtaining the specified patterns, the monitor system must detect any out of tolerance changes in the radiation characteristics resulting from physical damage or other deformation of the items used.

2-3.4.3.3.7 Vertical RF pattern.- Vertical directivity shall be designed into each antenna element such that the peak of the major lobe shall occur at an elevation angle not greater than 15 degrees and the beam width of the major lobe shall be not greater than 16 degrees at the half-power points when the antenna is mounted one wavelength above ground. Minor lobes shall be at least 8 dB below the peak of the major lobe when mounted as specified above.

2-3.4.3.3.8 Array height.- The overall height of the array including reflectors if used when mounted on the normal array support, shall not exceed 10 feet.

2-3.4.3.3.9 Intercoupling.- The isolation between those adjacent antenna elements in the array with the closest spacing as measured between the input connector of the driven element and the monitor output of the undriven element shall be at least 26 dB.

2-3.4.3.3.10 Integral monitoring.- Integral monitoring signals shall be provided for all arrays which are directly proportional to the radiated signal. The monitoring signals from the elements in each single frequency array shall be combined in such a manner that two separate RF signals are provided which describe the radiated signal "on-course" and the radiated signal at angles 1.5 to 3.0 degrees "off-course". The monitoring signals from the elements in the two-frequency array shall be combined in such a manner that 2 separate RF signals are provided which describe the radiated signals "on-course" and the radiated signal at angles 1.5 to 3.0 degrees "off-course" for the course array and 2 separate RF signals are provided which describe the radiated signal at angles of 8.0 to 10.0 degrees "off-course" for the clearance array. These monitoring signals so provided shall correlate with the signals that would be obtained with monitoring dipoles at the specified locations in the unobstructed far field. No tuning shall be required in the detector or monitor combining network for changes in frequency or input power. In addition to these specifications, the developed monitor signals shall be of a nature to comply in full with the intent and the specifications for monitoring localizer arrays as specified in paragraphs 2-3.4.3.4 thru 2-3.4.3.4.2. A weather proof box with removable cover shall be provided to house the monitor combining unit or at the contractor's option, the combining unit may be housed in the RF distribution unit (2-3.4.3.3.4).

readjustment. After initial adjustment under normal test conditions, changes from the initial room temperature readings occurring between 0.5 seconds and fifteen minutes after initial application of radiated signals under each of steps 3, 6, and 8 of the type test procedure of Specification FAA-G-2100 (modifies FAA-G-2100 for this application) and throughout the remainder of the test shall not exceed 25 percent of the change from nominal to the alarm threshold specified in 2-3.4.3.4.2.

2-3.4.3.4.2 Fault conditions.- The monitor shall detect a fault and initiate appropriate action if any of the following occur:

(a) A shift of the course position corresponding to 5 percent of the nominal course width, of a type I, type II or type III system or 3 percent of the nominal course width of a type V system.

(b) A change in displacement sensitivity (course width) exceeding 17 percent of nominal.

(c) A radiated DDM of less than .139 between $\pm$ 10 degrees to $\pm$ 35 degrees.

(d) A reduction of radiated localizer RF power of 3 dB from nominal in a single frequency system or 1 dB from nominal in either the course or clearance signal in a two frequency system.

(e) A change of the 90 and 150 Hz modulation percentages outside the 18 to 22 percent limits.

(f) Identification tone continuously present for more than 17 seconds.

(g) Identification tone absent for more than 17 seconds.

(h) Reduction of identification modulation percentage. (Threshold adjustable over range of 2.5 to 12 percent modulation).

(i) An open or shorted connector on either end of any antenna feedline.

(j) Mechanical misalignment of the antenna array that results in an out-of-tolerance condition in the far field that is not detected by the integral monitor.

(k) An open or shorted connector on either end of any integral monitor feedline shall cause an alarm.

2-3.4.3.4.2.1 Far field monitor.- The far field monitor of a type V system shall detect a fault and initiate appropriate action if any of the following occur:

(a) a shift of the course position corresponding to 3 percent of the nominal course width.

(b) a total loss of the radiated RF signal.

2-3.4.3.4.3 Monitor action.- The localizer monitor shall have an adjustable preset delay time, adjustable from the maximum monitor stabilization time category (see Paragraph 2-3.4.3.4.1) to at least 10 seconds. If a station fault (2-3.4.3.4.2) persists beyond this preset delay time, the monitor shall initiate the following action:

(a) Cause radiation of the localizer transmitter to cease.

(b) Cause transfer to the standby transmitter at a dual facility and activate the standby transmitter. If the fault persists for the additional preset period of time following transfer, the station shall shut down. The standby transmitter shall not be activated if a mechanical misalignment alarm (paragraph 2-3.4.3.4.2j) is initiated.

(c) Following shutdown, initiate a local aural and visual alarm and transmit the alarm indications to the remote control point.

2-3.4.3.4.4 Localizer monitor fail safe.- The localizer monitor/s shall be fail-safe such that failure of any parts of the monitor shall either result directly in an alarm condition, or shall not alter any alarm threshold level such as to allow an out-of-tolerance condition to occur without detection. For such parts as electronic or electromagnetic switching devices where it is not practical to provide fail-safe operation under both modes of failure (open circuit and short circuit), fail-safe protection shall be provided for the mode of failure having the higher probability.

2-3.4.4 UHF glide slope station.- The basic glide slope station shall be a single frequency design for use in a "null reference" configuration. The glide slope transmitter and associated equipment shall be designed in a manner that will readily accept a minimum of components for a modular expansion to either a sideband reference or capture effect configuration. The basic null reference equipment shall not require any modification to accomplish the conversion to either a sideband reference or capture effect configuration.

2-3.4.4.1 Null reference glide slope station.- A complete null reference UHF glide slope station shall consist of the following:

(a) Transmitter group with associated modulation and control equipment.

(b) One complete glide slope antenna group consisting of two identical directional transmitting antennas, including power divider networks, with integral monitoring probes and combining networks, associated cabling and a 40 foot tower consisting of a 20 foot base section, one 10 foot section and two 5 foot sections.

(c) One glide slope monitor group, including a single on-path monitor antenna, a monitor support mast and two sets of detectors if required.

(d) A type I or a type V station (2-1.2) shall include automatic changeover equipment (2-3.4.4.2.6)

2-3.4.4.1.1 Sideband reference glide slope station.- A complete sideband reference glide slope station shall consist of the equipment described in 2-3.4.4.1 plus the addition of a sideband reference amplitude and phase control assembly.

2-3.4.4.1.2 Capture effect glide slope station.- A complete capture effect glide slope station shall consist of the equipments described in 2-3.4.4.1 plus the following items:

(a) One additional glide slope antenna of the same type provided for a null reference facility.

(b) One clearance transmitter for a type II or a type IV system.

(c) One amplitude and phase control assembly.

(d) One 20 foot tower section to increase the height of the antenna tower of 2-3.4.4.1 to a maximum of 60 feet.

(e) One auxiliary rack (if required).

(f) One clearance signal monitor for a type II or a type IV system.

(g) Clearance cancellation network for interface with null reference pickup loop monitor network (see 2-3.4.4.7.3.2).

(h) Two clearance transmitters for a type I or type V system.

(i) Two clearance signal monitors for a type I or type V system.

2-3.4.4.2 UHF glide slope station performance.- The UHF glide slope station shall provide guidance in the vertical plane to aircraft engaging in approaches to and landings at airfields. The radiation from the UHF glide slope antenna group shall produce a composite field pattern that is amplitude modulated by 90 Hz and 150 Hz tones. The glide slope shall be capable of an adjustment to produce glide path angles between two and four degrees. The pattern shall be arranged to provide a straight line descent path in the vertical plane containing the runway centerline, with the 150 Hz tone predominating below the path and the 90 Hz tone predominating above the path, to at least an angle equal to 1.75 of the glide angle. The glide path angle shall be maintained within 0.075 of the commissioned glide path angle. The downward extended straight portion of the ILS glide path shall pass through the ILS reference datum at a height ensuring safe and efficient use of the runway served. This height, at runway threshold, shall be a nominal 50 feet, but shall not fall outside the limits of 37 to 60 feet.

2-3.4.4.2.1 Radio frequency.- The glide slope transmitter shall be capable of operation in 0.150 MHz increments across the band of 328.6 to 335.4 MHz. The frequency tolerance shall not exceed ± 0.002 percent over the service conditions. For a capture effect glide slope configuration employing two carriers, the frequencies of the RF carriers shall be individually adjustable and the nominal band occupied by the carriers shall be symmetrical about the assigned frequency. With all tolerances applied, the frequency separation between the carriers shall not be less than seven, or more than nine KHz.

2-3.4.4.2.2 Polarization.- The emission from the glide slope antenna array shall be horizontally polarized.

2-3.4.4.2.3 Coverage.- With the transmitter power output reduced to the monitor RF level alarm, the glide slope shall provide signals sufficient to allow satisfactory operation of a typical aircraft installation in a sector of eight degrees on each side of the runway centerline extended to a distance of at least 10 nautical miles up to 1.75 of the glide slope angle and down to 0.45 of the glide slope angle or the angle corresponding to 0.22 DDM, whichever is lower.

2-3.4.4.2.4 Carrier modulation.- The nominal depth of modulation of the RF carrier due to each of the 90 Hz and 150 Hz tones shall be 40 percent and shall be maintained within the limits of 37.5 and 42.5 percent.

2-3.4.4.2.5 Displacement sensitivity.- The angular displacement sensitivity shall be as symmetrical as possible. The nominal angular displacement sensitivity shall correspond to a DDM of 0.0875 at an angular displacement of 0.35 degrees above and below the glide path. This value corresponds to a deflection of ± 75 microamperes. The DDM below the ILS glide path shall increase smoothly for decreasing angle until a value of 0.22 DDM is reached. This corresponds to a "fly up" deviation of 190 microamperes. This value shall be achieved at an angle of not less than 0.30 of the glide slope above the horizontal. However, if it is achieved at an angle greater than 0.45 of the glide slope angle, the DDM shall remain equal to or greater than 0.22 DDM down to 0.45 of the glide slope angle. The glide path width and angle shall be so adjusted that an aircraft flying in such a way as to just clear all obstructions between the outer marker and the threshold obtains a signal of no less than 180 microamperes (0.21 DDM) "fly up". With the glide path widened or lowered to the alarm point, no less than 150 microamperes (0.175 DDM) shall be obtained. The angular displacement sensitivity shall be adjusted and maintained within ± 15 percent of the nominal value selected.

2-3.4.4.2.6 Automatic changeover unit (dual facility).- The automatic changeover unit shall cause the main transmitter to cease radiation (when a station fault 2-3.4.4.7.3, is detected) and cause the standby transmitter to radiate. The changeover unit shall configure the antenna system to the radiating transmitter.

2-3.4.4.3 Transmitter.- The transmitter shall consist of an RF module and a modulator assembly.

2-3.4.4.2.1 Radio frequency.- The glide slope transmitter shall be capable of operation in 0.150 MHz increments across the band of 328.6 to 335.4 MHz. The frequency tolerance shall not exceed ± 0.002 percent over the service conditions. For a capture effect glide slope configuration employing two carriers, the frequencies of the RF carriers shall be individually adjustable and the nominal band occupied by the carriers shall be symmetrical about the assigned frequency. With all tolerances applied, the frequency separation between the carriers shall not be less than seven, or more than nine KHz.

2-3.4.4.2.2 Polarization.- The emission from the glide slope antenna array shall be horizontally polarized.

2-3.4.4.2.3 Coverage.- With the transmitter power output reduced to the monitor RF level alarm, the glide slope shall provide signals sufficient to allow satisfactory operation of a typical aircraft installation in a sector of eight degrees on each side of the runway centerline extended to a distance of at least 10 nautical miles up to 1.75 of the glide slope angle and down to 0.45 of the glide slope angle or the angle corresponding to 0.22 DDM, whichever is lower.

2-3.4.4.2.4 Carrier modulation.- The nominal depth of modulation of the RF carrier due to each of the 90 Hz and 150 Hz tones shall be 40 percent and shall be maintained within the limits of 37.5 and 42.5 percent.

2-3.4.4.2.5 Displacement sensitivity.- The angular displacement sensitivity shall be as symmetrical as possible. The nominal angular displacement sensitivity shall correspond to a DDM of 0.0875 at an angular displacement of 0.35 degrees above and below the glide path. This value corresponds to a deflection of ± 75 microamperes. The DDM below the ILS glide path shall increase smoothly for decreasing angle until a value of 0.22 DDM is reached. This corresponds to a "fly up" deviation of 190 microamperes. This value shall be achieved at an angle of not less than 0.30 of the glide slope above the horizontal. However, if it is achieved at an angle greater than 0.45 of the glide slope angle, the DDM shall remain equal to or greater than 0.22 DDM down to 0.45 of the glide slope angle. The glide path width and angle shall be so adjusted that an aircraft flying in such a way as to just clear all obstructions between the outer marker and the threshold obtains a signal of no less than 180 microamperes (0.21 DDM) "fly up". With the glide path widened or lowered to the alarm point, no less than 150 microamperes (0.175 DDM) shall be obtained. The angular displacement sensitivity shall be adjusted and maintained within ± 15 percent of the nominal value selected.

2-3.4.4.2.6 Automatic changeover unit (dual facility).- The automatic changeover unit shall cause the main transmitter to cease radiation (when a station fault 2-3.4.4.7.3, is detected) and cause the standby transmitter to radiate. The changeover unit shall configure the antenna system to the radiating transmitter.

2-3.4.4.3 Transmitter.- The transmitter shall consist of an RF module and a modulator assembly.

2-3.4.4.3.4 Control functions.- A control shall be provided to turn the transmitter output radiation on and off. In addition, it shall be possible to select either local or remote control of this function.

2-3.4.4.3.5 Crystal.- Two of each required crystal shall be furnished with each transmitter in accordance with a listing of channel frequency assignments which will be furnished by the Government. In order to change the transmitter frequency, the crystal shall be the only component requiring replacement. The crystal shall be easily removable from a plug-in socket. In lieu of a set of crystals, transmitter frequency may be controlled by a crystal-referenced synthesizer adjustable over the full frequency range of 328 to 336 MHz in steps of 0.15 MHz.

2-3.4.4.3.6 Crystal oven.- A crystal oven shall not be used.

2-3.4.4.3.7 Resonance points.- There shall be no indication of more than one resonance point over the complete range of travel of adjustment for all controls normally used in tuning or adjusting the transmitter to meet equipment specification requirements. This requirement shall be met over the specified frequency range either during the procedure of tuning the transmitter or after all stages are tuned to resonance, regardless of the transmitter power output.

2-3.4.4.3.8 Indicator lights.- Indicator lights shall be provided and mounted on the front panel of the RF module to indicate the application of AC power and local remote control.

2-3.4.4.3.9 Modulator assembly design.- The modulator assembly shall provide (1) an output containing the RF carrier modulated by the navigation tones and (2) an output containing only the separate sideband frequencies of the navigation tones. The modulator shall be of electronic, solid state design.

2-3.4.4.3.10 Modulation tones.- The modulating tones shall be 90 Hz and 150 Hz within ± 1.5 percent.

2-3.4.4.3.11 Audio phase of modulation tones.- The modulating tones shall be so phase-locked that the demodulated 90 and 150 Hz signals appearing at the carrier output pass through zero within 50 microseconds of each other in the same direction, every 1/30 second.

2-3.4.4.3.12 Carrier modulation.- Modulation of the carrier output signals over a minimum range of 36 to 44 percent shall be accomplished by the use of a control which shall not produce a change of more than ± five degrees in RF phase between carrier and sideband outputs, measured over the full range of service conditions of temperature and humidity. Adjustment of the modulation control over the range specified herein shall have no effect on path structure or symmetry of path width.

2-3.4.4.3.13 Modulation balance adjustment.- A control shall be provided for precisely adjusting the total modulation balance. Throughout the range of adjustment of the modulation percentage control, and without making any other adjustments within the modulator, adjustment of the modulation balance control shall provide total modulation balance.

2-3.4.4.3.14 Sideband amplitude control.- A sideband amplitude control shall be provided to enable adjustment of the glide path full sector width of 0.80 degrees to 2.0 degrees. Adjustment of this control over its full range shall not cause the phase to change more than ± 5 degrees as measured over the service conditions of temperature and humidity.

2-3.4.4.3.15 RF phaser control.- A phasing control shall be provided for shifting the RF phase of-the signals appearing at the sideband output over a range of at least ± 60 degrees from normal. With the complete facility radiating and properly phased, the phaser control shall be set at mid-range ± 20 percent. Adjustment of this control over its full range shall not cause the amplitude to change more than ± 0.25 db.

2-3.4.4.3.16 Modulator navigation tone control.- A control shall be provided to enable independent removal of the navigation tones from the RF carrier.

2-3.4.4.3.17 Modulator test circuits.-For test purposes, a detected sample of the carrier output and sideband output shall be provided at convenient test jacks. The sampled signals shall be a minimum of 300 millivolts into a 20 K ohm load.

2-3.4.4.3.18 Carrier signal at sideband output.- With the modulator adjusted for optimum conditions, for any combination of sideband amplitude control or sideband phaser control settings, the carrier power appearing at the sideband output shall be 30 dB or more below the carrier power appearing at the carrier output when measured over the service conditions of temperature and humidity.

2-3.4.4.3.19 Distortion of demodulated navigation tones.- With the equipment adjusted for optimum conditions, the signals appearing at the carrier output test jack and sideband output test jack when it is properly demodulated, shall be such as to produce a demodulated signal with equal 90 and 150 Hz components and distortion components which do not exceed the following.

Frequency	Distortion component referred to 90 or 150 Hz signal
180 Hz	3 percent
270 Hz	4 percent
300 Hz	4 percent
450 Hz	4 percent
All other frequencies within the range of 30 to 4000 Hz	2 percent

In addition, the total harmonic distortion shall not exceed 10 percent. The above distortion requirements shall also be met when the input power to the modulator is varied over the specified range of the transmitter power output.

2-3.4.4.3.14 Sideband amplitude control.- A sideband amplitude control shall be provided to enable adjustment of the glide path full sector width of 0.80 degrees to 2.0 degrees. Adjustment of this control over its full range shall not cause the phase to change more than ± 5 degrees as measured over the service conditions of temperature and humidity.

2-3.4.4.3.15 RF phaser control.- A phasing control shall be provided for shifting the RF phase of-the signals appearing at the sideband output over a range of at least ± 60 degrees from normal. With the complete facility radiating and properly phased, the phaser control shall be set at mid-range ± 20 percent. Adjustment of this control over its full range shall not cause the amplitude to change more than ± 0.25 db.

2-3.4.4.3.16 Modulator navigation tone control.- A control shall be provided to enable independent removal of the navigation tones from the RF carrier.

2-3.4.4.3.17 Modulator test circuits.-For test purposes, a detected sample of the carrier output and sideband output shall be provided at convenient test jacks. The sampled signals shall be a minimum of 300 millivolts into a 20 K ohm load.

2-3.4.4.3.18 Carrier signal at sideband output.- With the modulator adjusted for optimum conditions, for any combination of sideband amplitude control or sideband phaser control settings, the carrier power appearing at the sideband output shall be 30 dB or more below the carrier power appearing at the carrier output when measured over the service conditions of temperature and humidity.

2-3.4.4.3.19 Distortion of demodulated navigation tones.- With the equipment adjusted for optimum conditions, the signals appearing at the carrier output test jack and sideband output test jack when it is properly demodulated, shall be such as to produce a demodulated signal with equal 90 and 150 Hz components and distortion components which do not exceed the following.

Frequency	Distortion component referred to 90 or 150 Hz signal
180 Hz	3 percent
270 Hz	4 percent
300 Hz	4 percent
450 Hz	4 percent
All other frequencies within the range of 30 to 4000 Hz	2 percent

In addition, the total harmonic distortion shall not exceed 10 percent. The above distortion requirements shall also be met when the input power to the modulator is varied over the specified range of the transmitter power output.

appropriate amplitude and phase relationship for delivery to the two transmitting antennas. Equal level sideband signals will be radiated from both the upper and lower antennas and carrier signals from only the lower antenna.

2-3.4.4.4.1 Sideband reference phaser.- A phaser shall be provided to adjust the phase of the sideband signals fed to the two antennas. With the phaser set to mid-scale, -the phase of the upper antenna output shall be 180 ± 5.0 degrees out of phase with the lower antenna output. The phaser shall have an electrical range of adjustment of at least 60 degrees each side of mid-scale and a mechanical range of adjustment of at least 40 degrees each side of mid-scale. Adjustment of this control over its full range shall not cause the amplitude to change by more than ± 0.25 dB.

2-3.4.4.4.2 Sideband reference amplitude control.- A continuously adjustable control shall be provided to adjust the ration of sideband power delivered to the upper and lower transmitting antennas. The range of control shall be such that it will vary the power fed to the two antennas in a linear manner. With the control set to mid-range the power output to each antenna output shall be equal.

2-3.4.4.4.3 Sideband reference carrier isolation.- With all phasers and power dividers set to mid-range, the carrier power at the upper antenna output shall be 26 dB or more below the carrier power at the lower antenna output.

2-3.4.4.4.4 Sideband reference line sections.- Built-in line sections shall be provided in each output for measuring RF power fed to each antenna. These line sections are in addition to the line sections installed in each transmitter output as specified in 2-3.3.10.

2-3.4.4.5 Capture effect amplitude and phase control assembly.- (Used with capture effect GS configuration only.) The capture effect amplitude and phase control assembly shall be designed to combine the separate carrier, sideband and clearance signals from the glide slope and clearance transmitter in the appropriate amplitude and phase relationship for delivery to three transmitting antennas. Carrier signals will be radiated from the lower and middle antennas, sideband signals from all three antennas and clearance signals from the upper and lower antennas.

2-3.4.4.5.1 Capture effect phasers.- Phasers shall be provided in each of the antenna outputs. At the contractor's option these phasers may be either an integral part of the Amplitude and Phase Control Unit (APCU) or external to the APCU assembly. If the phasers are external to the APCU assembly, they shall be mounted in the external RF network of 2-3.4.4.6.12. Each phaser shall have an electrical range of adjustment of at least 35 degrees each side of mid-scale and a mechanical range of at least 1.5 inches of linear travel or 40 degrees of rotational travel each side of mid-scale. At the output of the APCU, the output to the upper antenna shall be in phase (± 5.0 degrees) with respect to the lower antenna output and simultaneously out of phase (180 ± 5 degrees) with respect to the middle antenna when a signal is fed to the sideband input. If the phasers are an integral part of the APCU, this requirement shall be met with all phasers set to mid-scale. Adjustment of these phasers over their full range shall not vary any output level of the APCU by more than ± 0.1 dB. The APCU shall be designed to allow adjustment of the carrier sideband to sideband only phase in the middle antenna output independent of the carrier sideband to sideband only phase in the lower antenna output,

2-3.4.4.5.2 Capture effect amplitude control.- Continuously adjustable controls shall be provided to divide the power as required to:

(a) Establish the proper ratio of the carrier power delivered to the lower and middle antenna outputs.

(b) Establish proper ratio of sideband power delivered to the upper and lower antenna outputs.

(c) Establish the proper ratio of the sideband power delivered to the middle antenna output with respect to the upper and lower antenna outputs.

Adjustment of each power divider throughout its range shall not change the RF phase at the antenna outputs by more than ± 2.0 degrees.

In lieu of continuously adjustable controls, a broadband, fixed ratio power divider similar in function to that feeding the localizer antenna system may be provided. This power divider shall provide the required power ratio for each antenna over the full range of operating conditions and environmental service conditions. The RF phase at the antenna outputs of the power divider shall not deviate by more than ± 2.0 degrees over the full operating frequency range and over the full range of environmental service conditions.

2-3.4.4.5.3 Capture effect carrier isolation.- With each phaser and power divider set to mid-range, the power at the upper antenna output, the sideband input and the clearance input shall be 40 dB or more below the incident power applied to the carrier input. The power at the clearance input shall be 33 dB or more below the incident power applied to the carrier input.

2-3.4.4.5.4 Capture effect carrier stability.- After initial adjustment under normal test conditions, the ratio of the power at the middle antenna output with respect to the power at the lower antenna output shall not vary more than ± 0.5 dB over the service conditions of temperature and humidity, Additionally, the phase of the signal at the middle antenna output shall not vary more than ± 5.0 degrees with respect to the phase of the signal at the lower antenna output as measured over the service conditions of temperature and humidity.

2-3.4.4.5.5 Capture effect sideband isolation.- With each phaser and power divider set to mid-range, the power at the carrier input shall be 40 dB or more below the incident power applied to the sideband input. The power at the clearance input shall be 33 dB or more below the incident power applied to the sideband input.

2-3.4.4.5.6 Capture effect sideband stability.- After initial adjustment under normal test conditions, the ratio of the power at the upper, middle and lower antenna signal outputs each with respect to the power of every other output shall not vary more than ± 0.5 dB under the service conditions of temperature and humidity. The sum of the powers at the upper, middle and lower antenna outputs shall not vary more than ± 0.5 dB. Additionally, the phase of the sideband signal at the upper, middle and lower antenna each with respect to every other output shall not vary more than ± 5.0 degrees and the phase of the sideband signal with respect to the carrier signal at the middle and lower antenna signal output shall not vary more than ± 5.0 degrees.

2-3.4.4.5.7 Capture effect clearance isolation.- With all phasers and power dividers set to their center positions, the power at the carrier input, sideband input and middle antenna output shall be 33 dB or more below the incident power applied to the clearance input.

2-3.4.4.5.8 Capture effect line sections.- Built-in line sections shall be provided for each individual antenna output. These line sections are in addition to the line sections installed in each transmitter output as specified in 2-3.3.10.

2-3.4.4.6 Glide slope antenna array.- The null reference or sideband reference glide slope antenna array shall consist of two identical antennas. The capture effect glide slope antenna array shall consist of three identical antennas and these shall be of the same design as those antennas provided for the null reference and sideband reference type station. All antennas shall be interchangeable.

2-3.4.4.6.1 Antenna configuration.- Each antenna may consist of single or multiple horizontally polarized elements combined with a reflector to meet the required gain and vertical and horizontal pattern requirements. Antenna elements and reflectors shall be of the same metal type to prevent electrolytic action where they join together. Antenna heaters or radomes or both may be utilized to satisfy the total requirements for operation under the environmental conditions specified.

2-3.4.4.6.2 Polarization.- The radiated signal of the antenna shall be horizontally polarized. The vertical component shall be at least 25 dB below the horizontal components as measured in front of the antenna and within ± 25 degrees in azimuth of a vertical plane perpendicular to the antenna and passing through the center of the antenna.

2-3.4.4.6.3 Gain.- The gain of the antenna shall be such that the free space radiation from the antenna at zero degrees in azimuth shall not be less than 10 dB above that of a lossless isotropic radiator.

2-3.4.4.6.4 Characteristic impedance.- The design center impedance of the components and assemblies shall be 50 ohms.

2-3.4.4.6.5 Front-to-back ratio.- The front-to-back ratio of radiated signal shall be not less than 16 dB.

2-3.4.4.5.6 Capture effect sideband stability.- After initial adjustment under normal test conditions, the ratio of the power at the upper, middle and lower antenna signal outputs each with respect to the power of every other output shall not vary more than ± 0.5 dB under the service conditions of temperature and humidity. The sum of the powers at the upper, middle and lower antenna outputs shall not vary more than ± 0.5 dB. Additionally, the phase of the sideband signal at the upper, middle and lower antenna each with respect to every other output shall not vary more than ± 5.0 degrees and the phase of the sideband signal with respect to the carrier signal at the middle and lower antenna signal output shall not vary more than ± 5.0 degrees.

2-3.4.4.5.7 Capture effect clearance isolation.- With all phasers and power dividers set to their center positions, the power at the carrier input, sideband input and middle antenna output shall be 33 dB or more below the incident power applied to the clearance input.

2-3.4.4.5.8 Capture effect line sections.- Built-in line sections shall be provided for each individual antenna output. These line sections are in addition to the line sections installed in each transmitter output as specified in 2-3.3.10.

2-3.4.4.6 Glide slope antenna array.- The null reference or sideband reference glide slope antenna array shall consist of two identical antennas. The capture effect glide slope antenna array shall consist of three identical antennas and these shall be of the same design as those antennas provided for the null reference and sideband reference type station. All antennas shall be interchangeable.

2-3.4.4.6.1 Antenna configuration.- Each antenna may consist of single or multiple horizontally polarized elements combined with a reflector to meet the required gain and vertical and horizontal pattern requirements. Antenna elements and reflectors shall be of the same metal type to prevent electrolytic action where they join together. Antenna heaters or radomes or both may be utilized to satisfy the total requirements for operation under the environmental conditions specified.

2-3.4.4.6.2 Polarization.- The radiated signal of the antenna shall be horizontally polarized. The vertical component shall be at least 25 dB below the horizontal components as measured in front of the antenna and within ± 25 degrees in azimuth of a vertical plane perpendicular to the antenna and passing through the center of the antenna.

2-3.4.4.6.3 Gain.- The gain of the antenna shall be such that the free space radiation from the antenna at zero degrees in azimuth shall not be less than 10 dB above that of a lossless isotropic radiator.

2-3.4.4.6.4 Characteristic impedance.- The design center impedance of the components and assemblies shall be 50 ohms.

2-3.4.4.6.5 Front-to-back ratio.- The front-to-back ratio of radiated signal shall be not less than 16 dB.

2-3.4.4.6.14 Radomes.- Radomes, if utilized shall be fabricated of Type III glass fiber base plastic material in accordance with L-P-383 (modifies specification FAA-G-2100). If radomes are utilized, all performance requirements of the antenna system shall be met with the radomes installed.

2-3.4.4.6.15 Antenna heaters.- If antenna heaters are utilized to meet the requirements for operation in sleet and snow, such requirements shall be deemed to have been met if the antenna heaters are successful in preventing the accumulation of snow, ice, or slush on critical surfaces of the antenna array (radiating and pickup elements, radome, if utilized, and reflector) under wind conditions of up to 50 mph at air temperatures down to -10 degrees C. The antenna heaters shall be thermostatically controlled with the thermostats adjustable within the range of +0 to +5 degrees centigrade. The heater shall be isolated both mechanically and electrically from the RF circuits, so that operation of the heater does not affect the antenna VSWR, radiation patterns, or signal characteristics from the monitor pickup devices.

2-3.4.4.6.16 Antenna heater master thermostat.- A master thermostat with a remote bulb or sensor shall be provided for mounting on the wall of the transmitter shelter to sense the outside free air temperature. The contacts shall be rated to carry the current and voltage required to operate the coil of the AC contactor. A mounting bracket shall be provided. The thermostat shall open and remain open for all temperatures below an adjustable setting between -12 and -18 degrees centigrade.

2-3.4.4.6.17 Antenna mounting.- The antennas and associated distribution units (when utilized) shall include mounting provisions to enable vertical mounting on the tower to produce glide angles between 2 and 4 degrees. Means shall also be provided to laterally offset the antennas, in 1 inch increments, a total of ± 18 inches from a centered position on the tower.

2-3.4.4.6.18 Antenna tower.- The glide slope antennas shall be mounted on a steel triangular-shaped sectionalized tower. The forward facing (toward the approach end of the runway) side of the tower shall be perpendicular to the runway centerline at the nearest point, on the runway opposite the tower. This side of the tower shall be perpendicular, whether or not the tower is of uniform size or tapers. Each tower shall be complete with a ladder with uniformly spaced steps a minimum of 16 inches wide and a maximum of 12 inches apart, obstruction lights, safety climbing-equipment, anchor bolts and other related hardware. Tower design shall be in accordance with paragraph 2-3.3.19.

2-3.4.4.6.19 Obstruction lights.- A double obstruction light in accordance with FAA Advisory Circular AC 150/5345-2 shall be provided at the top of the tower. The lamps shall be wired in parallel and shall be rated at 100 watts each.

2-3.4.4.6.20 Safety climbing-equipment.- Safety climbing-equipment shall be provided for all structures 20 feet or more in height except when ladders are mounted inside towers, provided the clearance from the centerline of the rungs to the nearest permanent object on the climbing side of the ladder does not exceed 28 inches (clearance provided by

2-3.4.4.6.14 Radomes.- Radomes, if utilized shall be fabricated of Type III glass fiber base plastic material in accordance with L-P-383 (modifies specification FAA-G-2100). If radomes are utilized, all performance requirements of the antenna system shall be met with the radomes installed.

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2-3.4.4.7.1.1 Near field monitor.- The near field pickup device and support for each type of glide slope system shall be provided as follows:

(a) (deleted)

(b) Sideband reference glide slope station. The near field pickup device and support shall be designed to be located on a rectangular, elevated screen counterpoise in order to minimize effects of changing ground conditions. The screen counterpoise shall extend from the glide slope antenna array to a point a minimum of 12 feet behind the near field pickup device and a minimum of 6 feet either side of the monitor pickup device. The screen counterpoise shall not be provided under this specification. The near field pickup device and suitable support shall be provided for location at a point in front of the glide slope antenna array determined to be the 300 $\pm$ 5 degree phase proximity point between the upper and lower antennas. The near field pickup device shall be positioned at a height to place it at the peak of the first lobe of the upper antenna. To facilitate adjustment the height shall be adjustable from 2 feet to 8 feet above ground level and the longitudinal positioning of the near field pickup device and support shall be adjustable by means of rails or other sliding assemblies over a 10 foot range. The near field monitor sensitivity shall be adjusted to indicate a fault condition if the signal from the near field pickup device exceeds that which would be produced by dephasing of the upper antenna to an out-of-tolerance condition (2-3.4.4.7.3).

(c) (deleted)

2-3.4.4.7.2 Glide slope monitor stabilization.- All monitor channels shall be stabilized within 0.5 seconds after initial application of radiated signals. For Category I ILS equipment, internal monitor control shall begin within 2.0 seconds after initial application of radiated signals when such signals are outside of allowable tolerances. For Category II and Category III ILS equipment, internal monitor control shall begin within 0.5 seconds after initial application of radiated signals when such signals are outside of allowable tolerances. Interaction of all monitor parameters shall be minimized allowing simple straightforward adjustments of all monitor parameters in turn with minimum readjustment. After initial adjustment under normal test conditions, changes from the initial room temperature readings occurring between 0.5 seconds and fifteen minutes after initial application of power under each of steps 3, 6, and 8 of the type test procedure of specification FAA-G-2100 (modifies FAA-G-2100 for this application) and throughout the remainder of the test shall not exceed 25 percent of the change from nominal to the alarm threshold specified in 2-3.4.4.7.3.

2-3.4.4.7.3 Fault conditions.- The monitor shall detect a fault and initiate appropriate action if any of the following occur:

(a) A shift of the mean glide path by more than ± 0.2 degrees. For angles less than 2.67 degrees, the tolerance shall be ± 0.075 times the path angle.

(b) A change in path half sector width exceeding ± 0.2 degrees of nominal.

(c) A reduction of radiated power of 3 dB from nominal.

(d) A change of the 90 and 150 Hz modulation percentages outside the 38.0 - 42.0 percent limits.

(e) A deterioration of the glide slope system that would result in an out-of-tolerance reduction of the below path clearances.

2-3.4.4.7.3.1 Capture effect glide slope monitor.- in addition to detecting the faults listed in paragraph 2-3.4.4.7.3, the following faults shall also be detected at a capture effect station.

(a) A reduction of the radiated power from the clearance transmitter of 1.5 dB from nominal.

(b) A reduction of the 150 Hz modulation of the clearance transmitter by 15 percent.

(c) An out-of-tolerance separation between reference and clearance transmitter frequencies.

2-3.4.4.7.3.2 Clearance cancellation.- At capture effect glide slope stations, the clearance signals picked up by the monitoring devices in the upper and lower antenna shall be canceled from the monitor path and width channels.

2-3.4.4.7.3.3 Monitor action - The glideslope monitor shall have an adjustable preset delay time, adjustable from the maximum monitor stabilization time (see Paragraph 2-3.4.4.7.2) to at least 10 seconds. If a station fault (2-3.4.3.4.2) persists beyond this preset delay time, the monitor shall initiate the following action:

(a) Cause radiation of the glide slope transmitter to cease.

(b) Cause transfer to standby transmitter at a dual facility. If the fault persists for the preset period of time following the transfer, the station shall shut down.

(c) Following shutdown, initiate a local aural and visual alarm and transmit the alarm indications to the remote control point.

2-3.4.4.7.4 Glide slope monitor fail-safe.- The glide slope monitors shall be fail-safe such that failure of any parts of the monitors shall either result directly in an alarm condition, or shall not alter any alarm threshold level such as to allow an out-of-tolerance condition to occur without detection. For such parts as electronic or electromagnetic switching devices, where it is not practical to provide fail-safe operation under both modes of failure (open circuit and short circuit) fail-safe protection shall be provided for the mode of failure having the higher probability.

2-3.4.5 VHF marker beacon station.- A complete single equipment VHF marker beacon station shall consist of the following:

(a) One transmitter group with associated monitor and modulation equipment.

(b) One antenna group with monitor pickup device and associated cabling, divider networks, connectors, hardware, etc., necessary to connect the transmitter to the antenna array and to mount the antenna to the steel tower herein specified.

(c) One standby battery power group.

(d) Steel antenna support tower.

2-3.4.5.1 VHF marker beacon station performance.- The VHF marker beacon station shall provide information about the distance to the runway threshold of an aircraft engaging in approaches to, and landing at, airfields. The marker beacon station in accordance with these requirements is capable of being used as an inner, middle or outer marker.

2-3.4.5.1.1 Coverage.- The marker beacon field pattern shall be defined by the locus of points at which a standard calibrated aircraft installation, set for "low" sensitivity, receives an audio signal in excess of 2 milliamperes while flying the limits of the localizer course line, 150 microamperes either side of the localizer centerline, or within ± 10% of the limits of the major axis shown on Figure 1, whichever is lesser. The field strength at the limits of coverage specified in Figure 1 shall be 1.5 millivolts per meter. In addition, the field strength within the coverage area shall meet the following requirements:

2-3.4.4.7.3.3 Monitor action - The glideslope monitor shall have an adjustable preset delay time, adjustable from the maximum monitor stabilization time (see Paragraph 2-3.4.4.7.2) to at least 10 seconds. If a station fault (2-3.4.3.4.2) persists beyond this preset delay time, the monitor shall initiate the following action:

(a) Cause radiation of the glide slope transmitter to cease.

(b) Cause transfer to standby transmitter at a dual facility. If the fault persists for the preset period of time following the transfer, the station shall shut down.

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(c) One standby battery power group.

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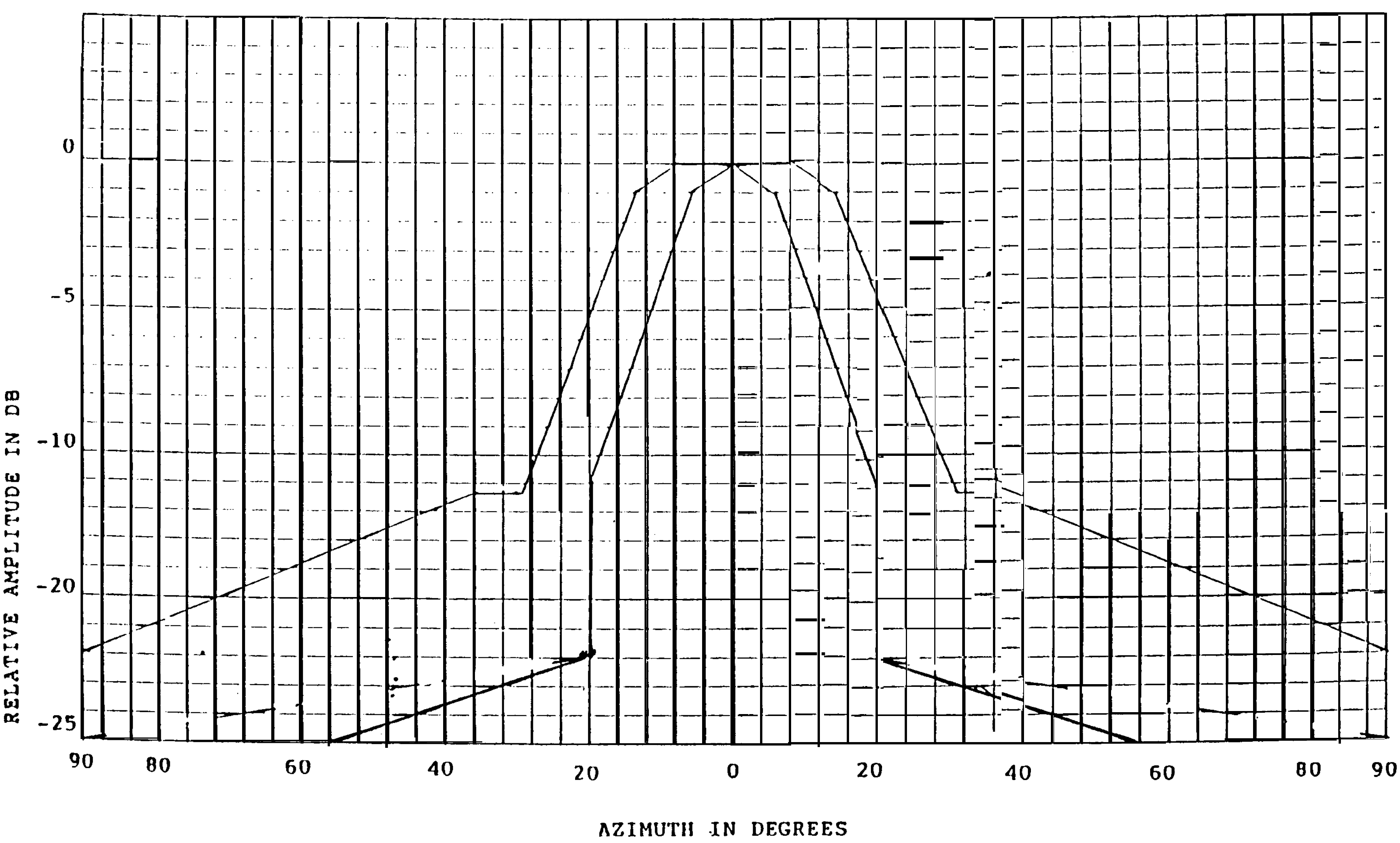
2-3.4.5.1.1 Coverage.- The marker beacon field pattern shall be defined by the locus of points at which a standard calibrated aircraft installation, set for "low" sensitivity, receives an audio signal in excess of 2 milliamperes while flying the limits of the localizer course line, 150 microamperes either side of the localizer centerline, or within $\pm$ 10% of the limits of the major axis shown on Figure 1, whichever is lesser. The field strength at the limits of coverage specified in Figure 1 shall be 1.5 millivolts per meter. In addition, the field strength within the coverage area shall meet the following requirements:



HORIZONTAL SPACE RADIATION PATTERN FOR ANTENNA

FIGURE 2

(a) When cut by a horizontal plane, the pattern shall be an ellipse with its minor axis parallel to the course line. The ratio of the ellipse major axis to the minor axis shall be a minimum of 1.5 to 1.0.

(b) When cut by a vertical plane in the minor axis, the pattern shall be within 25 percent of the limits shown in Figure 1. Minor axis coverage shall be measured on the localizer course and descending on the glide path. Coverage shall extend to an altitude of at least 3,000 feet above the station.

(c) The radiation shall be horizontally polarized.

(d) Major axis coverage shall be measured at the instrument approach procedures use altitude.

2-3.4.5.2 Marker beacon transmitter.- One transmitter shall be furnished for each marker beacon station, and each transmitter shall be complete with a modulator, a tone generator, an identification keyer and front panel multimeter with a selector switch to display the DC supply voltage, critical RF test points, modulation percentage, and the monitor output for purposes of tuning-up and servicing the transmitter.

2-3.4.5.2.1 Frequency.- The design center transmitter output frequency shall be 75 MHz. All specified requirements shall be met at this output frequency. The output frequency shall be within ± 0.005 percent of the design center value over the specified service conditions.

2-3.4.5.2.2 Carrier output.- The full rated carrier power output of the transmitter shall be not less than 2.5 watts over the service conditions as measured at a 50 ohm unbalanced resistive load terminating the transmitter output.

2-3.4.5.2.2.1 Power output adjustment.- It shall be possible to vary the normal output power from not less than 2.5 watts to no more than 0.25 watts for an outer marker and from not less than 1.0 watt to not more than 0.05 watts for a middle or inner marker.

2-3.4.5.2.3 Modulation frequency.- The transmitter shall include built-in tone generating and modulating facilities so that it can be modulated at any level from 70 to 97 percent by any of the following selectable frequencies.

(a) 400 Hz (Outer Marker)
(b) 1300 Hz (Middle Marker)
(c) 3000 Hz (Inner Marker)

2-3.4.5.2.3.1 Modulation frequency tolerance.- Each modulation frequency shall be within ± 1.5 percent of the design center frequency under normal test conditions. Variation of each modulation frequency shall not exceed 2.5 percent of the design center frequency under the service conditions. A control shall be provided for adjustment of the audio frequency to its nominal value.

(a) When cut by a horizontal plane, the pattern shall be an ellipse with its minor axis parallel to the course line. The ratio of the ellipse major axis to the minor axis shall be a minimum of 1.5 to 1.0.

(b) When cut by a vertical plane in the minor axis, the pattern shall be within 25 percent of the limits shown in Figure 1. Minor axis coverage shall be measured on the localizer course and descending on the glide path. Coverage shall extend to an altitude of at least 3,000 feet above the station.

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detection. For such parts as electronic or electromagnetic switching devices where it is not practical to provide fail-safe operation under both modes of failure (open circuit and short circuit), fail-safe protection shall be provided for the mode of failure having the higher probability.

2-3.4.5.4.2 Alarm controls.- Control(s) capable of varying the alarm threshold(s) shall be provided as necessary to meet the above monitoring requirements (2-3.4.5.4). These requirements shall be met with any transmitter output from rated power to 10 percent of rated power. It shall be possible to validate all alarm thresholds without external test equipment.

2-3.4.5.4.3 Alarm stability.- With the alarm thresholds adjusted under normal test conditions to provide alarms as stated above (2-3.4.5.4), the monitor shall indicate an alarm under the service conditions as follows:

(a) Carrier output -1.5 dB to -4.0 dB
(b) Modulation tone removed
(c) Unkeyed modulation

2-3.4.5.4.4 Alarm shutdown.- When an alarm condition occurs during normal unattended operation, the monitor unit shall automatically shut down the transmitter. Following a monitor initiated shutdown or restoration of primary AC power an automatic attempt at restart shall occur at (50) fifty seconds ± 5 seconds after shutdown and again at 15 minutes ± 30 seconds after the initial shutdown if the first attempt is unsuccessful. If either restart attempt is successful the restart circuitry shall automatically return to the full enable state. If the station is still inoperative after two attempts at restart, no further automatic attempts at restart shall be made. After two failed automatic restarts, restart of the station shall be accomplished by a manual reset. Provisions shall also be made for a remote restart capability such that momentary closure of a set of contracts at the remote monitor point will initiate the restart.

2-3.4.5.4.5 Remote alarm output.- When an alarm occurs, the alarm indicator at the remote status indicator (2-3.4.8) shall be activated.

2-3.4.5.4.6 Normal-bypass switch.- The marker beacon station shall be furnished with a normal-bypass switch. The normal-bypass switch shall allow the temporary disabling of the automatic shutdown function for maintenance purposes.

2-3.4.5.4.7 Battery disconnect switch.- The marker beacon station shall be equipped with a battery disconnect switch. The battery disconnect switch shall enable the battery output voltage to be disconnected from the transmitting equipment. The switch shall be manually operated and shall be automatically returned to the normal position when all maintenance access is secured.

2-3.4.5.5 Standby power.- A continuously engaged or floating battery power supply shall be provided for the marker beacon station for continued normal operation if the primary power fails. To maintain the batteries in operational readiness, a trickle charge shall be supplied to recharge the batteries during the period of available primary power. Upon loss and subsequent restoration of power, the batteries shall be restored to full charge within 24 hours from a 50 percent discharged condition. When primary power is applied, the state of the battery charge shall in no way cause harm to or affect the operation of the marker station. The battery supply shall permit continuation of normal operation for not less than one week under the normal test conditions. Additionally, the equipment shall meet all specification requirements with the exception of standby power requirements without batteries installed.

2-3.4.5.5.1 Control.- A switch and indicator light shall be provided for the control of primary AC power to the marker beacon station.

2-3.4.5.5.2 Carrier power stability.- After initial adjustment of the carrier power to 2.5 watts output, the carrier power shall not vary more than ± 10 percent over the full range of service conditions.

2-3.4.5.6 Transmitter cabinet.- The transmitter, monitor and battery charger power supply shall be housed in an aluminum or steel cabinet designed to be mounted inside the marker beacon station shelter. The cabinet shall be vented as required for adequate convection cooling with (RF) screening as required to meet equipment performance requirements.

2-3.4.6 Control equipment.- The localizer and glide slope local control equipment shall provide the following:

(a) Local on/off control and status indication of the transmitting equipment at the appropriate stations.

(b) Automatic shutdown of the operating transmitter or transfer to the standby transmitter in response to monitor initiated action (see (f) below). In a type I or type V station (2-1.2), the control unit will cause shutdown of the standby transmitter in the event of another monitor alarm.

(c) Automatic station turn-on following loss and restoration of primary power. (see paragraph 2-3.3.8.1).

(d) A time delay to insure that short transient conditions shall withhold shutdown of the equipment during the time delay preset period (2-3.4.6.1).

(e) Capability of monitoring the localizer station identification signal by means of sound-powered handset or permanent magnet head phones. (This provision may be incorporated into a unit other than the control unit at the contractor's option).

(f) For single channel equipment, type II, III or IV (2-1.2), the control unit shall provide automatic timed restart of the appropriate station transmitting equipment following monitor initiated shutdown action. The automatic attempt at restart shall occur at (50) fifty seconds ± 5 seconds after shutdown and again at 5 minutes ± 30 seconds after the initial shutdown if the first attempt was unsuccessful. If either restart attempt is successful, the restart circuitry shall automatically return to the full enable state. If the station is still inoperative after charge within 24 hours from a 50 percent discharged condition. When primary power is applied, the state of the battery charge shall in no way cause harm to or affect the operation of the marker station. The battery supply shall permit continuation of normal operation for not less than one week under the normal test conditions. Additionally, the equipment shall meet all specification requirements with the exception of standby power requirements without batteries installed.

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(b) Automatic shutdown of the operating transmitter or transfer to the standby transmitter in response to monitor initiated action (see (f) below). In a type I or type V station (2-1.2), the control unit will cause shutdown of the standby transmitter in the event of another monitor alarm.

(c) Automatic station turn-on following loss and restoration of primary power. (see paragraph 2-3.3.8.1).

(d) A time delay to insure that short transient conditions shall withhold shutdown of the equipment during the time delay preset period (2-3.4.6.1).

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(f) For single channel equipment, type II, III or IV (2-1.2), the control unit shall provide automatic timed restart of the appropriate station transmitting equipment following monitor initiated shutdown action. The automatic attempt at restart shall occur at (50) fifty seconds ± 5 seconds after shutdown and again at 5 minutes ± 30 seconds after the initial shutdown if the first attempt was unsuccessful. If either restart attempt is successful, the restart circuitry shall automatically return to the full enable state. If the station is still inoperative after

(g) Inclusion of a two terminal input, one terminal of which is a positive voltage supply not to exceed 50 volts for the purpose of interlocking the Instrument Landing System with equipment not to be supplied under this specification. A contact closure between the two terminals with a resistance of less than 350 ohms shall cause the main equipment of the localizer, the glide slope and each of the marker beacon stations to energize after a 20 $\pm$ 4 second delay. An open circuit with a resistance greater than 10,000 ohms shall cause all transmitting equipment of the localizer, glide slope and each marker beacon station to shutdown without delay. Loss of AC primary power at the ILS control unit shall cause the localizer, the glide slope or the marker beacon station to remain in their previously selected state of either energized or shutdown.

(h) Inclusion of two spare monitor channels identical to those supplied for the marker beacon stations. The two spare monitor channels shall provide visual indication of the status of two alarm relay contacts supplied by equipment not to be furnished under this specification. The two alarm relay contacts shall be located at the localizer and outer marker beacon station respectively. A contact closure at the remote site supplied by equipment not to be furnished under this specification with a resistance less than 350 ohms shall result in activation of the green "normal" light of the appropriate channel; an open circuit with a resistance greater than 10,000 ohms shall result in activation of the red "alarm" light.

2-3.4.8.1.1 Type V ILS status control unit.- The status control unit furnished with a type V system shall duplicate the design of the status control unit of 2-3.4.8.1 and shall additionally provide indication (2-3.4.8.1(2)) of the status of the inner marker and the localizer far field monitor, The far field monitor channel shall have a time delay control that can be adjusted to delay the aural alarm indication from 0 to 30 seconds after loss of the "normal" voltage and the resultant illumination of the red "alarm" light. The time delay will automatically be reinitialized (set to zero) immediately upon restoration of the "normal" signal. The type V status control unit shall also have the capability to completely bypass the far field monitor including the generation of the localizer shut down signal (2-3.5.3.2.(b)).

2-3.4.8.2 ILS status unit.- This unit shall provide the following functions:

(a) Visual indication of the status of the localizer, glide slope and both marker beacon stations by the use of green "normal" and red "alarm" (abnormal) indicating lights slaved to the indicator lights of the ILS Status Control Unit (2-3.4.8.1).

(b) An aural alarm which operates simultaneously with the operation of any of the red "alarm" (abnormal) lights to indicate an abnormal condition of the localizer, glide slope or either marker beacon station.

(c) An alarm silence switch.

(d) Inclusion of two spare status indicator "channels" identical to those supplied for the marker beacon stations.

The ILS status unit shall be a completely enclosed metal structure not to exceed 6" X 6" X 6" designed either for desk top use or for mounting within a rectangular cut-out in-an operating console. Facilities for connection to the ILS status control unit shall be provided by recessed male connectors.

2-3.4.8.2.1 Type V ILS status unit.- The ILS status unit furnished with a type V system shall duplicate the design of the status unit of 2-3.4.8.2 and shall additionally provide indication (2-3.4.8.2.(a)) of the status of the inner marker and the localizer far field monitor.

2-3.4.8.3 Control lines.- The remote monitoring and control functions shall be accomplished utilizing audio tones over a single voice - grade balanced telephone line pair (not supplied under this specification) connecting the ILS status control unit to the localizer, the glide slope and each of the marker beacons. The output amplitude of the tones shall be adjustable from -30 dBm to + 6 dbm with a nominal impedance of 600 ohms. Requirements shall be met over the complete range of adjustment.

2-3.4.9 Remote status indication equipment.- Localizer and glide slope monitor receivers designed in accordance with Specification FAA-E-2357 shall be provided to remotely monitor the status of the localizer and glide slope stations as specified in the invitation for bids or request for proposals and as further specified herein. Crystals for the receiver shall be furnished with the transmitters in accordance with 2-3.4.3.2.5 and 2-3.4.4.3.5. A full ILS shall be provided with a Type I receiver and antenna, a Type II receiver and antenna and a remote status unit each in accordance with FAA-E-2357. A Type III or Type IV Station (2-1.2) shall include only the Type I or Type II receiver and antenna, as applicable, and the remote status unit, each in accordance with FAA-E-2357.

A frequency synthesizer may be used to control the receiver frequency in lieu of a crystal. In lieu of conformance with MIL-E-38510, microelectronic components used in the receiver must be vendor tested in accordance with MIL-STD-883. Plastic packaged microelectronic components must not be used.

(c) An alarm silence switch.

(d) Inclusion of two spare status indicator "channels" identical to those supplied for the marker beacon stations.

The ILS status unit shall be a completely enclosed metal structure not to exceed 6" X 6" X 6" designed either for desk top use or for mounting within a rectangular cut-out in-an operating console. Facilities for connection to the ILS status control unit shall be provided by recessed male connectors.

2-3.4.8.2.1 Type V ILS status unit.- The ILS status unit furnished with a type V system shall duplicate the design of the status unit of 2-3.4.8.2 and shall additionally provide indication (2-3.4.8.2.(a)) of the status of the inner marker and the localizer far field monitor.

2-3.4.8.3 Control lines.- The remote monitoring and control functions shall be accomplished utilizing audio tones over a single voice - grade balanced telephone line pair (not supplied under this specification) connecting the ILS status control unit to the localizer, the glide slope and each of the marker beacons. The output amplitude of the tones shall be adjustable from -30 dBm to + 6 dbm with a nominal impedance of 600 ohms. Requirements shall be met over the complete range of adjustment.

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A frequency synthesizer may be used to control the receiver frequency in lieu of a crystal. In lieu of conformance with MIL-E-38510, microelectronic components used in the receiver must be vendor tested in accordance with MIL-STD-883. Plastic packaged microelectronic components must not be used.

2-3.5 LOCALIZER FAR FIELD MONITOR

2-3.5.1 Localizer far field monitor general requirements.- The VHF localizer subsystem far field monitor shall consist of the following:

(a) Three monitor antennas

(b) Two far field monitor receivers

(c) Two monitor units

(d) Combining/time delay/control circuits

(e) Far field monitor equipment cabinet

(f) Battery shelter equipped with stand-by batteries

(g) Interface cables

The far field monitor antenna array design shall consist of two independent horizontally polarized, directional, minimum 6 dB gain over isotropic, antennas that will be located on appropriate frangible (2-3.4.3.3.12) steel or aluminum support structures at or near the inner marker beacon site. The far field monitor equipment shall be used in conjunction with the localizer subsystem. Monitored data shall be transmitted to the localizer station and the remote indication and control point through telephone cable pairs, each pair having a DC loop resistance of approximately 2000 ohms. The far field monitor unit shall operate properly on independent standby power for a minimum of 72 hours after loss of the primary power source over the environmental service conditions.

2-3.5.2 Far field monitor receiver performance.- The far field monitor unit shall be equipped with two VHF receivers designed to meet the following requirements over the environmental service conditions:

(a) Frequency range - 108 to 112 MHz.

(b) Sensitivity - two microvolts for 10 dB (S+N)/N, 20 percent modulation, 90 Hz.

(c) IF image rejection - 90 dB minimum.

(d) Frequency stability - $\pm$ 35 x 10^{-6}.

(e) Localizer channel selector shall be a plug-in crystal or frequency synthesizer.

(f) Desensitization - for a desired signal of 5 microvolts, 30 percent modulation, a 4-volt signal at $\pm$ 4 MHz from the desired signal shall cause a loss of gain of no more than 2 dB.

(g) Cross modulation - with an input signal of 5 microvolts, an undesired signal at a level of 5 millivolts, separated from the desired signal by $\pm$ 50 KHz and modulated at 50 percent shall cause no more than 10 percent distortion.

(h) Selectivity - 15 KHz minimum at -6 dB
35 KHz maximum at -60 dB
60 KHz maximum at -90 dB

(i) Input impedance - 50 ohms ± 10 ohms.

(j) Audio frequency response - for 20 percent modulation at 90 Hz and 150 Hz the audio output amplitudes shall be within ± 0.1 dB of each other.

(k) Audio output level - for a 20 microvolt input signal 20 percent modulated at 90 Hz, the output shall be adjustable from 0 to at least 125% of the minimum required for the monitor input.

(l) AGC - The AGC threshold shall be 20 microvolts minimum.

(m) The output shall vary no more than 3 dB as the input is varied from AGC threshold to 10 millivolts.

(n) Detector linearity - The AC output shall vary linearly from zero to 60 percent modulation. The DC output shall not change appreciably as the percent of modulation is varied.

(o) Output impedance - 20 K ohms maximum.

(p) Audio distortion - The audio distortion at 90 Hz and 150 Hz shall be no more than 5 percent with an RF input of 50 microvolts to 10 millivolts with modulation levels up to 50 percent.

2-3.5.3 Far field monitor and control panel.- The far field monitor shall provide dual channel monitoring of the localizer course signal for proper alignment and RF signal level. It shall generate an alarm signal if either of the monitor channels indicates that the course alignment exceeds preset DDM limits (adjustable between zero and ± .015 DDM) or a loss of RF signal for a period of 0 to 30 seconds (adjustable at the remote status indication and control unit).

2-3.5.3.1 Monitor channels.- Two identical monitor channels shall be provided to monitor the on-course DDM of the 90 Hz and 150 Hz signals of the localizer. The outputs of the monitor channels shall be provided to the control panel. The individual monitor channels shall reset the localizer shutdown alarm time delay to zero each time the DDM, as seen by the monitor, is within allowable limits for a period equal to or greater than 50 milliseconds. This provision may be incorporated in the control panel at the contractor's option.

2-3.5.3.2 Control panel.- The control panel shall perform the following functions:

(a) Provide display of the DDM both locally and remotely at the localizer station. The localizer DDM display unit to be furnished shall be designed for mounting (by the government) in the localizer equipment rack or cabinet.

(b) Provide a shutdown signal to the localizer after a preset time delay which shall be adjustable between 0 and 120 seconds.

(c) Provide an alarm signal to the remote status indication and control unit immediately upon activation of an alarm condition.

2-3.5.4 Far field monitor equipment cabinet and battery shelter requirements.- The far field monitor electronic subassemblies shall be housed in a double-walled equipment cabinet suitable for mounting on a concrete hardstand. Inner and outer front covers shall also be provided as specified.

(a) Equipment cabinet.- The outer cabinet shall be vented to provide convection cooling of the equipment while simultaneously providing protection against rain and screening against insects. The inner cabinets shall be vented as required for adequate convection cooling with RF screening as required to meet equipment performance requirements. A duplex convenience outlet shall be installed inside the inner cabinet and shall be wired for 120 VAC operation.

(b) Covers.- The shelter shall be provided with inner and outer covers. The inner cover shall be top-hinged and secured by means of quarter turn captive fasteners (Dzus or equivalent) along the bottom and side edges. A movable bar shall be provided to support the cover in a horizontal position as a rain shield. The hinges shall be detachable to permit complete removal of the cover when desired. When positioned as a rain shield, the cover shall not interfere with removal of modules or use of extender cards.. The outer cover shall be removable by captive thumb screws. A hasp shall be furnished for attachment of a padlock to prevent unauthorized access to the equipment within the cabinet.

(c) Battery shelter.- An insulated aluminum housing shall be furnished to contain the batteries needed to satisfy the power requirements of the far field monitor and shall be designed for mounting on a platform. It shall provide adequate protection against damage caused by electrolyte leakage. It shall have a hinged door, provide adequate weather protection for the batteries, and shall permit the necessary air flow for ventilation. A hasp shall be furnished for a padlock to preclude unauthorized access to the equipment.

2-3.5.5 Far field monitor prime and standby Dower requirements.- Primary power for the far field monitor shall be 3-wire, 120/240 volts ac, single phase service. Standby power shall be provided by batteries operating in conjunction with a battery charger/power supply unit specified as follows:

(a) Battery.- The far field monitor shall be equipped with a sealed lead-acid type storage battery (Gel-Cell or equivalent) capable of operation in the temperature range from -10 degrees C to +70 degrees C. The battery shall provide standby operation for a minimum of 72 hours in the event of a primary power failure.

(b) Battery charger/power supply.- A battery charger/power supply

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(b) Battery charger/power supply.- A battery charger/power supply

2-3.6 DOCUMENTATION REQUIREMENTS

2-3.6.1 Documentation to be furnished.- Documentation for the localizer antenna arrays, localizer antenna elevated support platforms, the glide slope antenna tower and near field detector support, the localizer far field monitor antenna support and the marker beacon antenna tower shall be prepared and furnished by the contractor, complete, in accordance with all requirements, and shall include the items indicated below. Submission times are as shown in the contract schedule.

(a) Standard layout drawings for the items specified above including typical site layout drawings for each.

(b) Erection drawings and specifications.

(c) Construction drawings and specifications including foundations, grounding and underground connections, and interface with the antenna(s).

(d) Design calculations, assumptions and parameters used to determine that the items to be furnished or proposed for use satisfy the service conditions specified herein.

2-3.6.2 Drawings.- All drawings shall be made on clear-print paper No. 1000 H or equal with the FAA title block in the lower right hand corner. Provide 1/2" border lines on the top, bottom, and right hand side. Provide 1 1/2" border on the left side. The drawings shall be made on "D" size sheets (22" x 34"). Sample title and index sheets will be furnished. Drawings will be prepared in accordance with FAA-STD-002. These drawings will be reduced in size by the FAA in the future. For this reason, the contractor shall take effort to assure that all drawings are clear and legible. The details and printing shall be of the size required for microfilming on 35 mm film. The minimum letter height for a 22" x 34" sheet will be 5/32" and .05" spacing between letters. All letters shall be vertical capital letters.

2-3.6.3 Design submission and approval.- The contractor shall furnish the Contracting Officer or his designated Technical Representative three copies of the standard layouts, the erection drawings and specifications, and the construction drawings and specifications for review and approval. Also three copies of calculations necessary to support all design requirements contained herein. No fabrication work shall be started until all design documentation has been approved by the Government. Design approvals shall in no way relieve the contractor from meeting the requirements of this specification.

2-3.6.4 Documentation.- The contractor or his authorized representative shall sign the original tracings of all drawings and the first page of all specifications, design calculations, or similar documents under the contractors' printed name and over the affixed replica of his professional seal or his registration certification number including the state or jurisdiction of issue.

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2-3.7 CONFIGURATION MANAGEMENT.

2-3.7.1 Configuration management program.- The contractor shall establish and maintain a program to assure proper configuration identification, control and accounting throughout the life of the contract.

2-3.7.2 Configuration management plan.- The contractor shall prepare a Configuration Management-plan as outlined in FAA-STD-021. The plan shall describe how the contractor intends to assure proper configuration identification, control audits and accounting. The plan shall reflect both hardware and software plans. The contractor shall be responsible for its implementation and application to subcontractors, vendors, and suppliers.

2-3.7.3 Configuration control.- The contractor shall establish and maintain a configuration management program in accordance with FAA STD-021 to insure positive control of the configuration of the Instrument Landing System and supporting equipment throughout the life of the Contract. This program shall provide for the orderly development and documentation of the details of the configuration of both the hardware and software during the design, development and production phases. The program shall result in an accurate system definition at the completion of all required tests, and acceptance of the first system by the Government. Upon acceptance of the first system, the equipment configuration, including the appropriate descriptive documentation, shall be baselined. Thereafter, the contractor shall submit any engineering change proposal which affects baselined hardware, software or documentation (e.g., instruction books, installation drawing, etc.) to the Government for approval in accordance with FAA Order 1800.8E.

2-3.7.4 Configuration audits

2-3.7.4.1 Functional configuration audits (FCA).- The contractor and the Government shall conduct an FCA on each configuration item as specified in the contract in accordance with FAA-STD-021 after completion of design qualification testing. The contractor shall be responsible for the support of the audit in accordance with MIL-STD-1521, Appendix E. The contractor shall prepare and submit agenda and minutes of the FCA to the Contracting Officer within 30 calendar days of the completion of the audit.

2-3.7.4.2 Physical configuration audits (PCA).- The contractor and the Government shall conduct a PCA on each hardware and software configuration item in accordance with FAA-STD-021. The contractor shall be responsible for 'support of the audit in accordance with MIL-STD-1521, Appendix F. Successful completion of the PCA establishes the product baseline. In the event that the PCA identifies incorrect engineering or technical data, the contractor shall correct the data to conform to the product baseline at no expense to the Government. The contractor shall prepare and submit agenda and minutes of the PCA to the Contracting Officer within 30 calendar days of the PCA.

2-3.7.5 Configuration status accounting.- Configuration status accounting shall be in accordance with the contractor's Configuration Management Plan. The Contractor shall comply with the requirements of FAA-STD-021 for reporting the accomplishment of updating retrofit changes to equipment and

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2-4. QUALITY ASSURANCE. RELIABILITY. AVAILABILITY/MAINTAINABILITY AND FAIL-SAFE PLANS AND PROCEDURES

2-4.1 General.- The contractor shall provide and maintain a quality control program in accordance with FAA-STD-016, and quality assurance provisions specified in section 4 of Specification FAA-G-2100 shall apply.

2-4.1.1 Reliability. maintainability and fail safe.- The contractor shall demonstrate by calculations and analytical evaluation that his proposed electronic equipment will meet the specified reliability, maintainability and fail-safe requirements. The design evaluation conducted by the contractor shall be consistent with the latest available reliability and maintainability engineering procedures contained in the documents of paragraph 2-2.2. The contractor shall await approval of the final design by the Government prior to proceeding with the final assembly of the equipment.

2-4.1.2 Equipment testing requirements.- The contractor shall submit proposed test procedures in accordance with the requirements of section 4 of Specification FAA-G-2100. The proposed test procedures must demonstrate that the equipment to be furnished complies with all of the requirements of this specification and as a minimum, includes the tests specified in Table 2-4.1 herein.

2-4.2 Reliability program

2-4.2.1 Reliability requirements.- All equipment provided by the contractor shall be produced under reliability programs which comply with the requirements of MIL-STD-785 and MIL Handbook 217.

2-4.2.2 Contractor submitted reliability program plan.- The contractor shall submit a reliability program plan which meets the requirements of MIL-STD-785, Task 101 and which shall also include as a minimum the following:

(a) Definition of the reliability program goals.

(b) How the reliability goals will be achieved.

(c) Design and construction techniques that will maximize system MTBF.

(d) Predictions of MTBF.

(e) An agenda of items to be covered in design reviews.

The reliability plan developed shall be in accordance with MIL-STD-785 and MIL Handbook 217.

2-4.2.3 Reliability analysis.- The contractor shall conduct reliability analysis which meets the requirements of MIL-STD-785 (Task Section 200, tasks 201, 202, an 203) and MIL Handbook 217. The reliability analysis conducted by the contractor will use ground, fixed environmental conditions in the calculations and shall also include the following as a minimum:

(a) A reliability block diagram of the equipment indicating all redundancies, series elements, voting logic, etc.

(b) Failure rates for each element of the equipment, where an element is defined as the lowest level of assembly for which failure rates are available.

(c) Parts selection in accordance with MIL-STD-785.

(d) References of all failure data and modification factors used to account for environmental conditions. Justification of these factors must be based on an engineering analysis.

(e) Estimates of the equipment reliability based on the above requirements.

(f) Documentation and justification of all assumptions concerning the reliability analysis.

2-4.2.4 Reliability program review.- The provisions of MIL-STD-785, task 103 apply. Major reliability program checkpoints or milestones on both activities and results (as they become available) shall be defined and integrated into overall system program control procedures. The FAA shall be notified at least 15 working days prior to each contractually scheduled formal reliability program review to permit participation by the FAA. The minutes of these formal reliability program reviews shall be provided to the FAA.

2-4.2.5 Status reports.- Quarterly status reports of the contractor's progress and accomplishments in conducting the Reliability Program shall be submitted to the Government. Each report shall, as a minimum, contain the work accomplished and results obtained, status summaries of the last reporting periods' programs that were unresolved and a list of current problems facing the contractor.

2-4.2.6 Failure reporting. analysis. corrective action system (FRACAS) summary.- The contractor shall establish and implement a closed loop procedure MIL-STD-785, task 104 and shall also as a minimum include the following: (1) collect data on failures occurring during all phases of his effort, including incoming part inspections, component engineering and debugging, production screening or burn-in tests and reliability acceptance tests; (2) statistically analyze the data to identify reliability problems and to assess the progress made in meeting reliability requirements; (3) perform engineering analyses of failed parts to ascertain the causes of the failures; (4) implement appropriate corrective action to preclude the recurrence of failures experienced; (5) perform follow-on audits as necessary to assure adequacy of corrective action. All data shall be available for FAA inspection.

2-4.2.7 Failure modes, effects and criticality analysis (FMECA).- The contractor shall conduct an FMECA to the part level in accordance with the provisions of MIL-STD-785, task 204 for type V systems as specified in the IFB or RFP. The FMECA must demonstrate that the proposed design for the type V localizer and glide slope stations will satisfy the continuity of service and the integrity of signal requirements indicated in paragraphs 2-

(a) A reliability block diagram of the equipment indicating all redundancies, series elements, voting logic, etc.

(b) Failure rates for each element of the equipment, where an element is defined as the lowest level of assembly for which failure rates are available.

(c) Parts selection in accordance with MIL-STD-785.

(d) References of all failure data and modification factors used to account for environmental conditions. Justification of these factors must be based on an engineering analysis.

(e) Estimates of the equipment reliability based on the above requirements.

(f) Documentation and justification of all assumptions concerning the reliability analysis.

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(a) Result directly in an alarm condition.

(b) Not alter any alarm threshold in the direction of tolerating greater deterioration of the system performance characteristics than permitted in the absence of such failure.

and also that failure of-any part of the control unit shall either:

(a) Result in an automatic shut-down of the associated facility.

(b) Not inhibit the control unit from accomplishing its intended functions in the event of a monitor alarm.

The fail-safe demonstration test plan shall be submitted together with the maintainability program plan (2-4.3.2.(i)).

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(b) Not alter any alarm threshold in the direction of tolerating greater deterioration of the system performance characteristics than permitted in the absence of such failure.

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(b) Not inhibit the control unit from accomplishing its intended functions in the event of a monitor alarm.

The fail-safe demonstration test plan shall be submitted together with the maintainability program plan (2-4.3.2.(i)).

TABLE 2-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENTS		TEST LEVEL AND METHOD					TEST LOCATION		REMARKS
PARAGRAPH NUMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-150/ ACT	
2-3.4.2	System Performance					D		X	
2-3.4.3.1	VHF Localizer Station Performance					D		X	
2-3.4.3.1.1	Radio Frequency	T					X		
2-3.4.3.1.2	Coverage					D		X	
2-3.4.3.1.3	Polarization					D		X	
2-3.4.3.1.4	Modulation	A					X		
2-3.4.3.1.5	Course Alignment Accuracy					D		X	
2-3.4.3.1.6	Displacement Sensitivity					D		X	
2-3.4.3.1.7	Course Sector Width					D		X	
2-3.4.3.1.8	Identification	T					X		
2-3.4.3.1.9	Automatic Changeover Unit					D		X	
2-3.4.3.2.1	Transmitter Output Power	T	T		T		X		
2-3.4.3.2.2	Transmitter Stability	T		T			X		
2-3.4.3.2.3	Stabilization Time	T		T			X		
2-3.4.3.2.4	Control Functions	I					X		
2-3.4.3.2.5	Crystal	T					X		Synthesizer Only
2-3.4.3.2.7	Resonance Points	T					X		
2-3.4.3.2.8	Indicator Lights	I					X		
2-3.4.3.2.10	Modulation Tones	T			T		X		

VERIFICATION METHODS: INSPECTION-I, ANALYSIS-A, TEST-T, DEMONSTRATION-D

TABLE 2-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENT		TEST LEVEL AND METHO					TEST CA		REMARKS
PARAGRAPH N-UMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-150/ ACT	
2-3.4.3.2.12	Carrier Modulation	T		T			xx		
2-3.4.3.2.13	Modulation Balance Adjustment	T			T				
2-3.4.3.2.14	Sideband Amplitude Control	T		T	T		X		
2-3.4.3.2.15	RF Phaser Control	T			T				
2-3.4.3.2.16	Modulation Navigation Tone Control	I					xx		
2-3.4.3.2.17	Modulator Test Circuits	T							
2-3.4.3.2.18	Carrier Signal at Sideband Output	T		T			xx		
2-3.4.3.2.19	Distortion of Demodu-lated Navigation Tones	T	T				X		
2-3.4.3.2.20	Identification Keyer	T		T	T				
2-3.4.3.2.20.1	DME Keying Output	T							
2-3.4.3.3.1	Array Options and Antenna Patterns	A				D	xxx	X	
2-3.4.3.3.2	Frequency Range	A				D	x	X	
2-3.4.3.3.4	RF Distribution Unit	T		T			x		
2-3.4.3.3.5	Course Width					D		X	

VERIFICATION METHODS: INSPECTION-I, ANALYSIS-A, TEST-T, DEMONSTRATION-D

TABLE 2-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENT		TEST LEVEL AND METHOD					TEST LOCATION		REMARKS
PARAGRAPH NUMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKEDOWN	FACTORY	APM-150/ ACT	
2-3.4.3.2.12	Carrier Modulation	T		T			xx		
2-3.4.3.2.13	Modulation Balance Adjustment	T			T				
2-3.4.3.2.14	Sideband Amplitude Control	T		T	T		X		
2-3.4.3.2.15	RF Phaser Control	T			T				
2-3.4.3.2.16	Modulation Navigation Tone Control	I					xx		
2-3.4.3.2.17	Modulator Test Circuits	T							
2-3.4.3.2.18	Carrier Signal at Sideband Output	T		T			xx		
2-3.4.3.2.19	Distortion of Demodulated Navigation Tones	T	T				X		
2-3.4.3.2.20	Identification Keyer	T		T	T				
2-3.4.3.2.20.1	DME Keying Output	T							
2-3.4.3.3.1	Array Options and Antenna Patterns	A				D	xxx	X	
2-3.4.3.3.2	Frequency Range	A				D	x	X	
2-3.4.3.3.4	RF Distribution Unit	T		T			x		
2-3.4.3.3.5	Course Width					D		X	

VERIFICATION METHODS: INSPECTION-I, ANALYSIS-A, TEST-T, DEMONSTRATION-D

TABLE 2-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENTS		TEST LEVEL AND METHOD					TEST LOCATION		REMARKS
PARAGRAPH NUMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-150/ ACT	
2-3.4.4.2.5	Displacement Sensitivity					D		x	
2-3.4.4.2.6	Automatic Changeover Unit					D		x	
2-3.4.4.3.1	Transmitter Output Power	T	T		T		X		
2-3.4.4.3.2	Transmitter Stability	T		T			X		
2-3.4.4.3.3	Stabilization Time	T		T			X		
2-3.4.4.3.4	Control Functions	I					X		
2-3.4.4.3.5	Crystal	T					X		Synthesizer Only
2-3.4.4.3.7	Resonance Points	T					X		
2-3.4.4.3.8	Indicator Lights	I					X		
2-3.4.4.3.10	Modulation Tones	T			T		X		
2-3.4.4.3.12	Carrier Modulation	T		T			X		
2-3.4.4.3.13	Modulation Balance Adjustment	T			T		X		
2-3.4.4.3.14	Sideband Amplitude Control	T		T	T		X		
2-3.4.4.3.15	RF Phaser Control	T			I		X		
2-3.4.4.3.16	Modulator Navigation Tone Control	I					X		

VERIFICATION METHODS: INSPECTION-I, ANALYSIS-A, TEST-T, DEMONSTRATION-D

TABLE 2-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENTS		TEST LEVEL AND METHOD					TEST LOCATION		REMARKS
PARAGRAPH NUMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-150/ ACT	
2-3.4.4.2.5	Displacement Sensitivity					D		X	
2-3.4.4.2.6	Automatic Changeover Unit					D		X	
2-3.4.4.3.1	Transmitter Output Power	T	T		T		X		
2-3.4.4.3.2	Transmitter Stability	T		T			X		
2-3.4.4.3.3	Stabilization Time	T		T			X		
2-3.4.4.3.4	Control Functions	I					X		
2-3.4.4.3.5	Crystal	T					X		Synthesizer Only
2-3.4.4.3.7	Resonance Points	T					X		
2-3.4.4.3.8	Indicator Lights	I					X		
2-3.4.4.3.10	Modulation Tones	T			T		X		
2-3.4.4.3.12	Carrier Modulation	T		T			X		
2-3.4.4.3.13	Modulation Balance Adjustment	T			T		X		
2-3.4.4.3.14	Sideband Amplitude Control	T		T	T		X		
2-3.4.4.3.15	RF Phaser Control	T			I		X		
2-3.4.4.3.16	Modulator Navigation Tone Control	I					X		

VERIFICATION METHODS: INSPECTION-I, ANALYSIS-A, TEST-T, DEMONSTRATION-D

TABLE 2-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENTS		TEST LEVEL AND METHOD					TEST LOCATION		REMARKS
PARAGRAPH NUMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-15°/ ACT	
2-3.4.4.4.3	Sideband Reference Carrier Isolation	T			T		X		
2-3.4.4.5	Capture Effect APCU	A					X		
2-3.4.4.5.1	Capture Effect Phasers	T	T				X		
2-3.4.4.5.2	Capture Effect Amplitude Control	T			T		X		
2-3.4.4.5.3	Capture Effect Carrier Isolation	T			T		X		
2-3.4.4.5.4	Capture Effect Carrier Stability	T		T			X		
2-3.4.4.5.5	Capture Effect Sideband Isolation	T			T		X		
2-3.4.4.5.6	Capture Effect Sideband Stability	T		T			X		
2-3.4.4.5.7	Capture Effect Clearance Isolation	T			T		X		
2-3.4.4.6.2	Polarization	T					X		
2-3.4.4.6.3	Gain	T					X		

VERIFICATION METHODS: INSPECTION-I, ANALYSIS-A, TEST-T, DEMONSTRATION-D

TABLE 2-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENTS		TEST LEVEL AND METHOD					TEST LOCATION		REMARKS
PARAGRAPH NUMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-15°/ ACT	
2-3.4.4.4.3	Sideband Reference Carrier Isolation	T			T		X		
2-3.4.4.5	Capture Effect APCU	A					X		
2-3.4.4.5.1	Capture Effect Phasers	T	T				X		
2-3.4.4.5.2	Capture Effect Amplitude Control	T			T		X		
2-3.4.4.5.3	Capture Effect Carrier Isolation	T			T		X		
2-3.4.4.5.4	Capture Effect Carrier Stability	T		T			X		
2-3.4.4.5.5	Capture Effect Sideband Isolation	T			T		X		
2-3.4.4.5.6	Capture Effect Sideband Stability	T		T			X		
2-3.4.4.5.7	Capture Effect Clearance Isolation	T			T		X		
2-3.4.4.6.2	Polarization	T					X		
2-3.4.4.6.3	Gain	T					X		

VERIFICATION METHODS: INSPECTION-I, ANALYSIS-A, TEST-T, DEMONSTRATION-D

TABLE 2-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENTS		TEST LEVEL AND METHOD					TEST LOCATION		REMARKS
PARAGRAPH NUMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-150/ ACT	
2-3.4.4.7.3.3	Monitor Action	D					X		
2-3.4.4.7.4	Glide Slope Monitor Fail-Safe	A,D,					X		
2-3.4.5.1.1	Coverage	A				D	X	X	
2-3.4.5.2.1	Frequency	T		T			X		
2-3.4.5.2.2	Carrier Output	T		T	T		X		
2-3.4.5.2.2.1	Power Output Adjustment	T					X		
2-3.4.5.2.3	Modulation Frequency	T					X		
2-3.4.5.2.3.1	Modulation Frequency Tolerance	T		T	T		X		
2-3.4.5.2.3.2	Modulation Harmonic Distortion	T			T		X		
2-3.4.5.2.4	Identification Keyer	T					X		
2-3.4.5.2.4.1	Character Timing	T					X		
2-3.4.5.2.4.2	Keyer Stability	T		T			X		
2-3.4.5.3	Transmitting Antenna					D		X	
2-3.4.5.3.1	Monitor Pick-up Antenna	T				D	X	X	
2-3.4.5.4	Monitor	T			T		X		
2-3.4.5.4.1	Fail-Safe	A,D,					X		

VERIFICATION METHODS: INSPECTION-I, **ANALYSIS-A,** TEST-T, DEMONSTRATION-D

TABLE 2-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENTS		TEST LEVEL AND METHOD					TEST LOCATION		REMARKS
PARAGRAPH NUMBER	TITLE	-IRST AR- DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-150/ ACT	
2-3.4.4.7.3.3	Monitor Action	D					X		
2-3.4.4.7.4	Glide Slope Monitor Fail-Safe	A,D,					X		
2-3.4.5.1.1	Coverage	A				D	X	X	
2-3.4.5.2.1	Frequency	T		T			X		
2-3.4.5.2.2	Carrier Output	T		T	T		X		
2-3.4.5.2.2.1	Power Output Adjustment	T					X		
2-3.4.5.2.3	Modulation Frequency	T					X		
2-3.4.5.2.3.1	Modulation Frequency Tolerance	T		T	T		X		
2-3.4.5.2.3.2	Modulation Harmonic Distortion	T			T		X		
2-3.4.5.2.4	Identification Keyer	T					X		
2-3.4.5.2.4.1	Character Timing	T					X		
2-3.4.5.2.4.2	Keyer Stability	T		T			X		
2-3.4.5.3	Transmitting Antenna					D		X	
2-3.4.5.3.1	Monitor Pick-up Antenna	T				D	X	X	
2-3.4.5.4	Monitor	T			T		X		
2-3.4.5.4.1	Fail-Safe	A,D,					X		

VERIFICATION METHODS: INSPECTION-I, **ANALYSIS-A,** TEST-T, DEMONSTRATION-D

-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

REQUIREMENTS		TEST LEVEL AND METHOD					TEST LOCATION		REMARKS
PARAGRAPH NUMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-150/ ACT	
2-3.5.3	Far Field Monitor and Control Panel	T			T		X		
2-3.5.3.1	Monitor Channels	T			T		X		
2-3.5.3.2	Control Panel	T			T		X		
2-3.5.5	Far Field Monitor Prime and Standby Power Requirements	A,T					X		
2-3.5.6	Monitor Fail-Safe	A,D,T					X		

VERIFICATION METHODS: INSPECTION-I, ANALYSIS-A, TEST-T, DEMONSTRATION-D

-4.1

INSTRUMENT LANDING SYSTEM-VERIFICATION REQUIREMENT TRACEABILITY MATRIX

PARAGRAPH NUMBER	TITLE	FIRST ARTICLE DESIGN QUALIFICATION	TYPE TEST NORMAL CONDITIONS	TYPE TEST SERVICE CONDITIONS	PRODUCTION TESTS	OPERATIONAL SHAKED OWN	FACTORY	APM-150/ ACT	REMARKS
2-3.5.3	Far Field Monitor and Control Panel	T			T		X		
2-3.5.3.1	Monitor Channels	T			T		X		
2-3.5.3.2	Control Panel	T			T		X		
2-3.5.5	Far Field Monitor Prime and Standby Power Requirements	A,T					X		
2-3.5.6	Monitor Fail-Safe	A,D,T					X		

VERIFICATION METHODS: INSPECTION-I, ANALYSIS-A, TEST-T, DEMONSTRATION-D

2-5 PREPARATION FOR DELIVERY

2-5.1 Preservation and packaging.- Preservation and packaging of items shall be in accordance with Military Specification Mil-E-17555, Level A, Method II.

2-5.2 Packing.- Packing of items shall be in accordance with MIL-E-17555, Level B. No more than one of each item and associated hardware shall be packed in each shipping container. Items sensitive to electrostatic discharge shall be packed in accordance with DOD-STD-1686.

2-5.3 Marking.- Each packing and or shipping container shall be durably and legibly marked with the following information:

(a) Name of item, part number, and FAA type designation
(b) Serial number(s)
(c) Quantity
(d) Contract number
(e) National stock number
(f) Gross weight and size (cubic units) of container
(g) Manufacturer's name

Each package, shipping container, replaceable item, and its container shall be marked with bar codes in accordance with MIL-STD-129.

2-5 PREPARATION FOR DELIVERY

2-5.1 Preservation and packaging.- Preservation and packaging of items shall be in accordance with Military Specification Mil-E-17555, Level A, Method II.

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(b) Serial number(s)
(c) Quantity
(d) Contract number
(e) National stock number
(f) Gross weight and size (cubic units) of container
(g) Manufacturer's name

Each package, shipping container, replaceable item, and its container shall be marked with bar codes in accordance with MIL-STD-129.

2-6 TRAINING

2-6.1 General requirements: The Contractor shall provide maintenance training for ILS equipment in accordance with this section, and in accordance with FAA-STD-028, entitled Contract Training Programs. This standard covers the format and content of training course materials, standards for training techniques used, facilities provided, and administration of training.

2-6.2 Specific training requirements:

2-6.2.1 Scope of training: The Contractor shall provide a traditional (lecture/laboratory) training program for maintenance of ILS equipment provided under this contract. Specifically:

(a) Localizer equipment
(b) Glide slope equipment
(c) Marker beacon equipment
(d) Remote control and monitoring equipment
(e) Antennas and RF power distribution
(f) Electrical power systems, including standby power

2-6.2.2 Training goals: The Contractor shall design the training program to allow the successful graduate to:

a. Adjust equipment for normal operation.
b. Identify and follow written maintenance procedures in instruction manuals.
c. Perform all periodic maintenance.
d. Measure and analyze all system operating parameters to determine whether or not the system is performing within specified tolerance limits.
e. Using diagnostic aids, built-in test equipment, and standard digital and analog troubleshooting aids, isolate system faults to the module or printed circuit board level.
f. Make system measurements and adjustments using remote control equipment if remote monitoring and control equipment is provided with systems purchased under this contract.

2-6.2.3 Skill level of trainees: Candidates for training will be FAA electronics technicians or engineers who have successfully completed FAA Course 40233, ILS Concepts, or the equivalent.

2-6.2.4 Modularity: The training program shall be developed in modular form so the following sections can stand alone:

(a) General theory of operation
(b) Localizer equipment
(c) Glide slope equipment
(d) Marker beacon equipment

Training for remote control and monitoring equipment which is common in theory and operating concepts to all applicable system units may be included with the Localizer training module at the Contractor's option.

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d. Measure and analyze all system operating parameters to determine whether or not the system is performing within specified tolerance limits.
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(a) General theory of operation
(b) Localizer equipment
(c) Glide slope equipment
(d) Marker beacon equipment

Training for remote control and monitoring equipment which is common in theory and operating concepts to all applicable system units may be included with the Localizer training module at the Contractor's option.

2-6.2.8 Instructional Materials: In reference to Section 4.6 of FAA-STD-028, the Contractor shall furnish all instructor and student materials for each class. At the conclusion of each class, students shall retain all course materials issued to them.

2-6.2.9 Course Evaluation: In reference to Section 4.7.10 of FAA-STD-028, the Contractor, rather than the FAA, shall administer the course evaluation. On the final day of class, each student shall complete the "General end-of-course" evaluation form. The Contractor shall submit the completed evaluation forms to the FAA Technical Officer within 5 working days after the completion of each class.

2-6.2.10 Training certification documents:

2-6.2.10.1 Certificate of training: The Contractor shall provide a certificate of training to each student who completes the training course with a passing grade. The certificate shall contain at least the following information:

(a) Course Title
(b) Number of hours of training completed
(c) Location of training
(d) Class start and end dates
(e) Student's name
(f) Instructor's signature

2-6.2.10.2 Class roster: The contractor shall provide a class roster to the FAA Technical Officer at the conclusion of each training class. The class roster shall include all information listed above for the training certificate. In addition, each student's social security number and course grade (either numerical or pass/fail) shall be included.

2-6.3 Contract data requirements: The Contractor shall submit the following data:

2-6.3.1 In accordance with the referenced sections of FAA-STD-028 and/or the specified Data Item Descriptions (DID) contained in Appendix II of FAA-STD-028:

(a) Time phasing Chart - Section 4.2.1 of FAA-STD-028
(b) Job task analysis - Section 4.7.1, DID-5, DID-12 of FAA-STD-028
(c) Contract training plan - Section 4.7.2, DID-6, DID-12 of FAA-STD-028
(d) Course design guide - Section 4.7.3, DID-7, DID-12 of FAA-STD-028
(e) Student and instructor materials - Section 4.7.4, DID-2, DID-8, DID-9, DID-10, DID-11, DID-12, DID-13, DID-14, DID-16 of FAA-STD-028
(f) Course validation report - DID-13 of FAA-STD-028

2-6.2.8 Instructional Materials: In reference to Section 4.6 of FAA-STD-028, the Contractor shall furnish all instructor and student materials for each class. At the conclusion of each class, students shall retain all course materials issued to them.

2-6.2.9 Course Evaluation: In reference to Section 4.7.10 of FAA-STD-028, the Contractor, rather than the FAA, shall administer the course evaluation. On the final day of class, each student shall complete the "General end-of-course" evaluation form. The Contractor shall submit the completed evaluation forms to the FAA Technical Officer within 5 working days after the completion of each class.

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(a) Course Title
(b) Number of hours of training completed
(c) Location of training
(d) Class start and end dates
(e) Student's name
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(b) Job task analysis - Section 4.7.1, DID-5, DID-12 of FAA-STD-028
(c) Contract training plan - Section 4.7.2, DID-6, DID-12 of FAA-STD-028
(d) Course design guide - Section 4.7.3, DID-7, DID-12 of FAA-STD-028
(e) Student and instructor materials - Section 4.7.4, DID-2, DID-8, DID-9, DID-10, DID-11, DID-12, DID-13, DID-14, DID-16 of FAA-STD-028
(f) Course validation report - DID-13 of FAA-STD-028

2-7 DEDICATED REPAIR SERVICE

2-7.1 Contractor Service: The Contractor shall furnish all labor, tools, test equipment, parts, software, and any other technical or administrative support necessary to provide the required Dedicated Repair Service (DRS) for Reparable Items and Components (RI&C) in accordance with the provisions of this section.

The purpose of the DRS is to provide for an accelerated repair turnaround time on selected reparable items failure, to the extent not covered by warranty, which occur during the period of time designated in the contract. The terms of this section shall become effective when the contract is modified by mutual agreement of the parties to establish the DRS, including an agreed-to list of RI&C and prices for their repair.

If the contract is modified to establish the DRS, the Contractor shall provide DRS beginning with the first day of the month immediately following the Government's acceptance of the first system of Item 1 of the Contract. At that time, the Contractor shall have the capability and expertise necessary to repair all RI&C. The DRS shall continue through the last day of the month of the contract period for the DRS. The DRS completion date shall be stated in the contract modification establishing the DRS.

2-7.2 Reparable Items and Components: Reparable items and components (RI&C) are those of a durable nature which, when unserviceable, normally can be restored to a serviceable condition by a repair activity. RI&C shall be repaired when the cost of repair is less than 65 percent of the replacement cost.

2-7.3 Testing. Inspection, and Acceptance: Testing, inspection, and final acceptance by the FAA of repaired items shall be accomplished in accordance with the test, inspection, and the acceptance requirements of the Contract. Requests for action, technical action requests, acceptance test procedures, and test data forms submitted and approved for the end item requirement on this contract are considered approved for the purpose of DRS and need not be re-submitted for approval.

2-7.4 Delivery Requirements of Repaired Items: The following priorities shall apply for delivery of repaired items. The designation of priority or routine delivery shall be made by an FAA Depot Item Manager.

(1) Priority - Seven (7) working days from receipt of the item or component by the Contractor until shipped to the designated recipient;

(2) Routine - Thirty (30) working days from receipt of the item or component by the Contractor until shipped to the designated recipient

2-7 DEDICATED REPAIR SERVICE

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The purpose of the DRS is to provide for an accelerated repair turnaround time on selected reparable items failure, to the extent not covered by warranty, which occur during the period of time designated in the contract. The terms of this section shall become effective when the contract is modified by mutual agreement of the parties to establish the DRS, including an agreed-to list of RI&C and prices for their repair.

If the contract is modified to establish the DRS, the Contractor shall provide DRS beginning with the first day of the month immediately following the Government's acceptance of the first system of Item 1 of the Contract. At that time, the Contractor shall have the capability and expertise necessary to repair all RI&C. The DRS shall continue through the last day of the month of the contract period for the DRS. The DRS completion date shall be stated in the contract modification establishing the DRS.

2-7.2 Reparable Items and Components: Reparable items and components (RI&C) are those of a durable nature which, when unserviceable, normally can be restored to a serviceable condition by a repair activity. RI&C shall be repaired when the cost of repair is less than 65 percent of the replacement cost.

2-7.3 Testing. Inspection, and Acceptance: Testing, inspection, and final acceptance by the FAA of repaired items shall be accomplished in accordance with the test, inspection, and the acceptance requirements of the Contract. Requests for action, technical action requests, acceptance test procedures, and test data forms submitted and approved for the end item requirement on this contract are considered approved for the purpose of DRS and need not be re-submitted for approval.

2-7.4 Delivery Requirements of Repaired Items: The following priorities shall apply for delivery of repaired items. The designation of priority or routine delivery shall be made by an FAA Depot Item Manager.

(1) Priority - Seven (7) working days from receipt of the item or component by the Contractor until shipped to the designated recipient;

(2) Routine - Thirty (30) working days from receipt of the item or component by the Contractor until shipped to the designated recipient

2-7.9 Shipping Instructions and Shipping Cost: Shipping instructions for repaired or replaced items shall be furnished by an FAA Depot Item Manager.

The Government shall pay all transportation costs of items to and from the Contractor's facility. All items shall be shipped to the Contractor prepaid. Upon return of the item to the Government, the Contractor-shall prepay all transportation charges and bill such charges as a separate item on its monthly invoice. If the shipping charge for any one destination exceeds $100, the waybill shall be marked "THESE TRANSPORTATION CHARGES ARE TO BE PAID AS A SEPARATE AND DIRECT ITEM BY THE U.S. GOVERNMENT. ANY SPECIAL U.S. GOVERNMENT TRANSPORTATION RATES MUST BE APPLIED."

2-7.10 Method of Shipment: Mode for shipment shall be commensurate with the designated priority of the requirement, and may be specifically designated by an FAA Depot Item Manager.

2-7.11 Contacts and Shinning Points: Specific offices of contact, names of individuals and contact points of appropriate FAA personnel and Contractor representatives shall be exchanged between the FAA and the Contractor subsequent to establishment of the DRS.

The Contractor shall identify the address for items shipped as follows:

(1) Address for all items shipped via United Parcel Service (UPS) or other freight lines.

(2) Address for all items shipped via parcel post or air mail.

2-7.12 Preservation, Packaging. Packing: All items shipped under this contract shall be preserved, packaged, and packed to provide adequate protection against damage shipment from the Contractor's plant to designation, and be in accordance with MIL-E-17555H. Marking for shipment shall be in accordance with MIL-STD-129, and packages shall be bar coded in accordance with MIL-STD-1189.

2-7.13 Data Accumulation and Reports Data shall be maintained and accumulated by the Contractor on repaired items to provide the following reports to the FAA Depot.

(1) Repair Status Report. The Repair Status Report shall be submitted on a weekly basis to the FAA Depot and include the following information:

(a) Part number
(b) Serial number (if applicable)
(c) Description
(d) Data received
(e) Facility from which received
(f) Data shipped
(g) -Failure Report (if applicable)
(8) Type of requirement - (Priority/Routine)

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2-8 NATIONAL AIRSPACE INTEGRATED LOGISTICS SUPPORT PROGRAM (NAILS)

2-8.1 Scope The Contractor shall plan, manage, and execute a NAILS Program in accordance with FAA Order 1800.58 and FAA NAILS Masters Plan. The NAILS Program is the total set of tasks, both management, and execution, required to accomplish the following objectives:

a. Cause supportability to be an integral part of system design and system requirements.

b. Define support requirements which are optimally related to the design and to each other.

c. Define the required support during the operational phase.

d. Prepare the attendant data products

MIL-STD-1388-1A and -2A shall be used as a reference for task guidelines. For new designs, the NAILS Program effort shall be conducted as an integral part of the design process. For existing designs requirements shall be analyzed and developed in accordance with the guidelines stated below and the requirements of MIL-STD-1388.

2-8.1.2 NAILS Program Management.

2-8.1.2.1 NAILS Manager. The Contractor shall designate a NAILS manager. The Contractor's NAILS manager shall be at a management level appropriate for managers of hardware development and engineering, and have an engineering specialty in matters relating to logistics support and life cycle cost impacts. The Contractor's NAILS manager shall serve as the focal point for the interface with the Government on all matters relating to the management of the NAILS program.

2-8.1.2.2 National Airspace Integrated Logistics Support Management Team (NAILSMT). Joint Government/NAILSMT for the Instrument Landing Systems (ILS) shall be established to serve as the primary management vehicle for monitoring the status of the NAILS Program implementation. The chairman of the NAILSMT shall be a Government representative. The NAILSMT shall provide a means for coordinating and monitoring schedule and contract performance thereby insuring adequacy, timeliness and compliance with established regulatory guidance and contracted requirements.

The NAILSMT shall meet at least once a year at the FAA Headquarters in Washington, DC. The first NAILSMT meeting shall be approximately three months after date of contract award.

The Contractor shall provide administrative support for and participate in NAILSMT meetings as required. The Contractor shall publish an agenda 30 days prior to the NAILSMT meetings. The Contractor shall assure participation of subcontractor personnel when necessary. The Contractor shall identify and document items requiring action at a joint NAILSMT meeting. The action items shall be submitted as agenda items for each NAILSMT meeting. The contractor shall attend, participate fully and take minutes of all NAILSMT meetings.

2-8.1.2.3 Integrated Support Plan (ISP) Development. The Contractor shall prepare and submit for Government review and approval, an ISP, using MIL-STD-1388 as a guide. This plan identifies the contractor's approach for implementing the NAILS program for the ILS. A preliminary plan will be submitted to the government for review and comment at the LSA Guidance Conference scheduled 30 days following Contract Award. After government approval, the ISP becomes the contractual document governing the contractor's NAILS effort. The Contractor is responsible for compliance with ISP requirements by all subcontractors and vendors.

2-8.1.3 NAILS Program Tasks.

2-8.1.3.1 Maintenance Planning. The Contractor shall plan the maintenance for the ILS. Maintenance planning is the effort to identify, document, and establish an effective and economical way for performing the total range and quantity of maintenance tasks on the ILS. Determination of the total range and quantity of maintenance tasks to ILS shall be consistent with the FAA's maintenance requirements as defined in FAA-E-2492. The Contractor shall closely examine design characteristics and inherent maintenance requirements to ensure compliance with existing FAA systems maintenance requirements.

2-8.1.3.2 Systems Engineering and Specialty Interface. The Contractor shall identify and perform the actions necessary to ensure that logistics requirements and maintenance factors are given equitable weight in decisions made by other system engineering areas. System engineering specialties include, but are not limited to: design, safety, standardization, and human factors.

2-8.1.3.3 Adverse Impacts. The Contractor shall notify the Government of decisions made by other system engineering areas which adversely impact logistic support requirements or maintenance planning factors. Such matters shall be included as action items for the NAILSMT meeting.

2-8.1.4 NAILS Element Development and Integration

2-8.1.4.1 Similar Work Efforts. The Contractor shall make maximum use of analysis and documentation being procured under other provisions (i.e., subcontractor Logistics Support Analysis (LSA) Data, common off-the-shelf equipment data) and as applicable and available, data from other government contracts and sources. The task analysis and equipment analysis shall not duplicate previously conducted analysis, data collection, and decision-making that went into compiling the data contained in these other sources. These similar work efforts shall be consolidated in such a way as to preclude duplication of work and ensure consistency.

2-8.1.4.2 Standardization. The Contractor shall accomplish all contractually required NAILS element developmental efforts using logistics requirements and maintenance planning guidance identified in MIL-STD-1388.

2-8.1.4.3 NAILS Schedules. The schedules for development and delivery of the individual NAILS elements shall be compatible and consistent with the development and delivery of contract line items. These schedules shall be fully integrated into the overall System Schedule.

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to the Government for approval Task 401 (less those task) noted above, which shall include applicable elements of Task 302.

2-8.2.2.5 Post Production Support Plan - Task 403. The Contractor shall conduct an analysis and submit a Post Production Support Plan, in accordance with DI-P-7119. The documented results shall be delivered to the Government 6 months after date of contract award.

2-8.2.2.6 Supportability Test, Evaluation and Verification - Task 501. The Supportability Test, Evaluation and Verification contained in the Supportability Assessment Plan shall be submitted in accordance with DI-S-7120. The documented results shall be delivered to the Government 6 months after date of contract award.

2-8.2.3 LSA Candidate Selection Procedures and Criteria. The Contractor shall perform LSA on all systems, subsystems, end items, components assemblies, subassemblies, support and test equipment, that are found to require operational and logistical support parameters documentation. The Contractor shall perform LSA on any item that does not have an existing documented maintenance record.

a. The Contractor shall prepare an initial list of LSA candidates. The list shall include a national stock number/manufacturer's part number, and item name as available. The initial list of candidate items shall be augmented by the Contractor as design engineering progresses.

b. Equipment of a temporary nature (i.e. special installation switches, temporary ports that may be removed within the contract maintenance period, transition switches, etc.) should not be considered as candidates.

c. The Government shall retain the right for final determination of candidate for selection, non selection or revised or additional LSA tasking.

2-8.2.4 LSA Record (LSAR). Data and information generated from the LSA shall be in accordance with MIL-STD-1388-2A, and MIL-STD-D-1561B and the requirements contained herein. The LSAR shall be developed as the central file of validated, integrated and design related logistic data for the ILS. The Contractor shall establish and maintain a Government certified Automated Data Processing (ADP) system to process and store LSAR data. All LSAR data manual or automated shall be producible in hard copy format in accordance with MIL-STD-1388-2A. The Contractor shall update LSAR documentation to reflect changes in support requirements resulting from Contractor or Government initiated design changes. Unless otherwise approved by the Government, the Contractor shall not deviate from the specified LSAR formats or utilize any supplemental formats in the LSA Plan.

2-8.2.4.1 Logistic Control Number (LCN) Assignment. The Contractor shall assign LCNs to individual equipment items to facilitate storage retrieval. The structure of the number shall represent a top down breakdown of the hardware and shall include support and test equipment, training equipment, and installation hardware items. Each item in the equipment from the end item down to each individual piece part shall be assigned a unique LCN for each application of the item throughout the system to identify its relationship to the next higher assembly. The LCN structure must agree with the hardware generation breakdown as it will be displayed in the engineering drawings for the equipment. The Contractor is responsible for ensuring the compatibility and integration of subcontractor/vendor LCNs within the overall coding arrangement. The first three characters of each LCN for the ILS shall be designated "GFC". The "GFC" LCN assigned to the ILS identifies the "A" identure level. The Contractor's proposed numbering system shall be described in the LSA plan and requires Government approval.

2-8.2.4.2 LSAR Data Review. The Contractor shall establish internal procedures that provide for progressive verification of the adequacy and technical accuracy of LSAR documentation. The Government reserves the right to periodically review and examine Contractor produced LSAR data, including LSAR input data records, LSAR output summaries, drawings, mock-ups, specification, ADP records, and photographic reproductions. The review of data from the Contractor's LSAR program shall be accomplished by members of the NAILSMT. The Contractor shall have available supportive material and rationale for all LSAR data presented for review.

2-8.2.4.3 Maintenance Plan Report. The contractor shall prepare and submit for Government approval, a Maintenance Plan Report consistent with the FAA concept of maintenance for the ILS; annual inspection, quarterly site visits for preventive maintenance, and maintainability in accordance with FAA-E-2492/2b Section 2-3.3.5.

2-8.2.4.4 Deleted

2-8.2.4.5 LSAR Delivery. The Contractor shall prepare and submit to the Government for approval the required LSAR Data. The Contractor shall deliver the LSAR data (DRAFT). The Contractor shall prepare and deliver to the Government for approval the remaining LSAR and the Supplementary Provisioning Technical Documentation in hard copy format as required by DD Form 1949-2 (Provisioning Requirements Statements), and MIL-STD-1388-2A.

2-8.2.4.6 LSAR Delivery Schedule. The Contractor shall incrementally deliver the LSAR master files (listed below) to the Government in a format capable of being processed on the Material Readiness Support Activity (MRSA) software schedule to be determined at the guidance conference.

a. Logistic Support Analysis Report 015 (the sequential task description report).

b. Logistic Support Analysis Report 060 (the LSA Control Number Master File to include all header information) prepared in accordance with DI-ILSS-80116.

application of the item throughout the system to identify its relationship to the next higher assembly. The LCN structure must agree with the hardware generation breakdown as it will be displayed in the engineering drawings for the equipment. The Contractor is responsible for ensuring the compatibility and integration of subcontractor/vendor LCNs within the overall coding arrangement. The first three characters of each LCN for the ILS shall be designated "GFC". The "GFC" LCN assigned to the ILS identifies the "A" identure level. The Contractor's proposed numbering system shall be described in the LSA plan and requires Government approval.

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a. Logistic Support Analysis Report 015 (the sequential task description report).

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d. Software/Firmware Documentation in accordance with MIL-STD-2167 and Data Item Descriptions DI-MCCR-80029 and DI-MCCR-80013 for all computer programs regardless of storage media (software and/or-firmware) delivered by the contractor.	2	set
e. Source code of all program data on g-track magnetic tape, 1600 bpi, EBCDIC coded tape in accordance with MRSA Rev 2, Release 3 Recorded Magnetic Tape (1600 bpi, phase EBCDIC coded).	1	set
f. Support Software having the following minimum capabilities: 1. Compilation 2. Assembly that produces relocatable object code 3. Linking Loader 4. Generation, maintenance and initialization of storage media for programs and data 5. Diagnostics to support fault isolation 6. Editing and debugging tools 7. Test tools	1	set
g. Item Identification in accordance with Paragraph 3.10 of Specification FAA-G-1210d.	As required	
2-8.2.5.3 Spare Parts Peculiar. Additional Spare Parts Peculiar for items 1 through 4 inclusive. These spare parts peculiar are to be identified following the Government review of the Provisioning Parts List or during a provisioning conference to be held at a time and place determined by the Government.	1	lot

2-8.2.5.4 Provisioning Guidance Conference. Meetings required to support the provisioning effort shall be addressed at the Provisioning Guidance Conference which will be held at the Contractor's facility no later than (NLT) 30 calendar days after Contract Award.

2-8.2.5.5 Provisioning Conference. A Provisioning Conference shall be held at the Contractor's facility NLT 30 days after Critical Design Review (CDR) The Spare Parts Provisioning List shall be delivered 30 days prior to CDR.

2-8.2.5.6 General Conferences. General conferences, in addition to the LSA Guidance Conference and Provisioning Conference, may be held at any time during the life of the contract for the purpose of resolving provisioning and/or supply support problems or issues. The Contractor shall attend, participate in, and assist the Government in resolving problems or issues at these meetings.

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2-9 CONTRACT MAINTENANCE (OPTION)

2-9.1 Scope: The Contractor shall perform all preventive and corrective maintenance for equipment purchased under this contract. Preventive maintenance shall be performed in accordance with the manufacturer's recommended preventive maintenance program. Corrective maintenance shall be performed as required. An on-site inspection shall be performed quarterly, and may be concurrent with preventive or corrective maintenance actions.

The Contractor shall provide the following:

a. All labor for both on-site and remote maintenance services.
b. Travel and subsistence for on-site maintenance.
c. All tools, materials and supplies.
d. Depot repair of repairable parts used in maintenance.
e. Replacement of throw-away parts used in maintenance.

The Government shall provide the following:

a. One set of the manufacturer's initial recommended site spare parts for each site under contract maintenance.
b. Storage on site for contractor's tools, test equipment, materials, and supplies.
c. Scheduled down-time for preventive maintenance and inspection.

2-9.2 System Availability: Quality of performance of system maintenance is measured in terms of system availability. The FAA, as part of its ongoing quality assurance program, computes and publishes system availability data for all systems which it maintains. The maintenance contractor is required to provide at least the same level of system availability that FAA maintenance provides for the same type of equipment. System availability is calculated by the following formula:

$$\text{System Availability} = \left(1 - \frac{\text{Accumulated Down Time}}{\text{Accumulated operating time}} \right) \text{X } 100\%$$

For the purpose of evaluation of maintenance performance under this contract, system availability shall be calculated for downtime caused by equipment failure and preventive maintenance only. Downtime due to other unscheduled causes such as failure of primary power for an extended period of time, failure of commercial communications lines, weather damage, radio interference, fire, vandalism, and acts of God shall not enter into system availability calculations.

For airports where 12 to 24 hour response time can be tolerated, system availability is typically 98% for Localizer and Glide Slope equipment. This figure is provided for guidance only and is not a specification.

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